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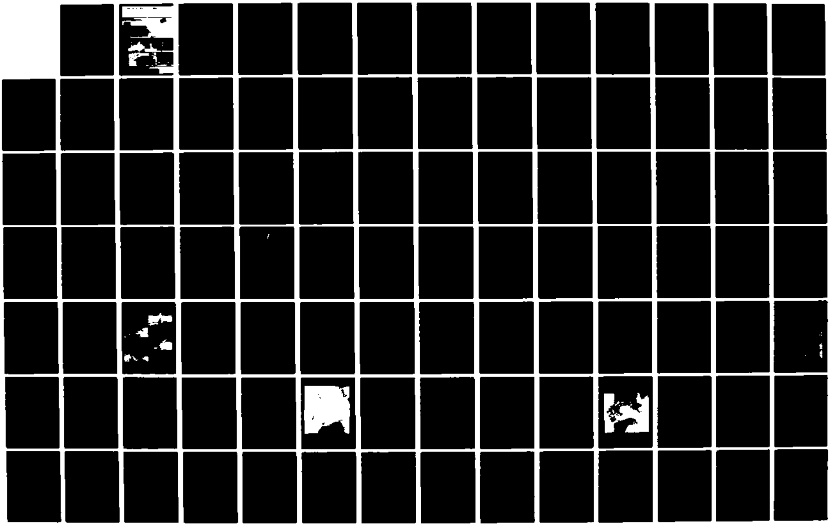

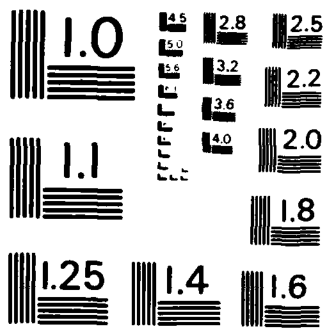

Chesapeake Bay Tidal Flooding Study

APPENDIX A - PROBLEM IDENTIFICATION
APPENDIX B - PLAN FORMULATION, ASSESSMENT AND EVALUATION
APPENDIX C - RECREATION AND NATURAL RESOURCES

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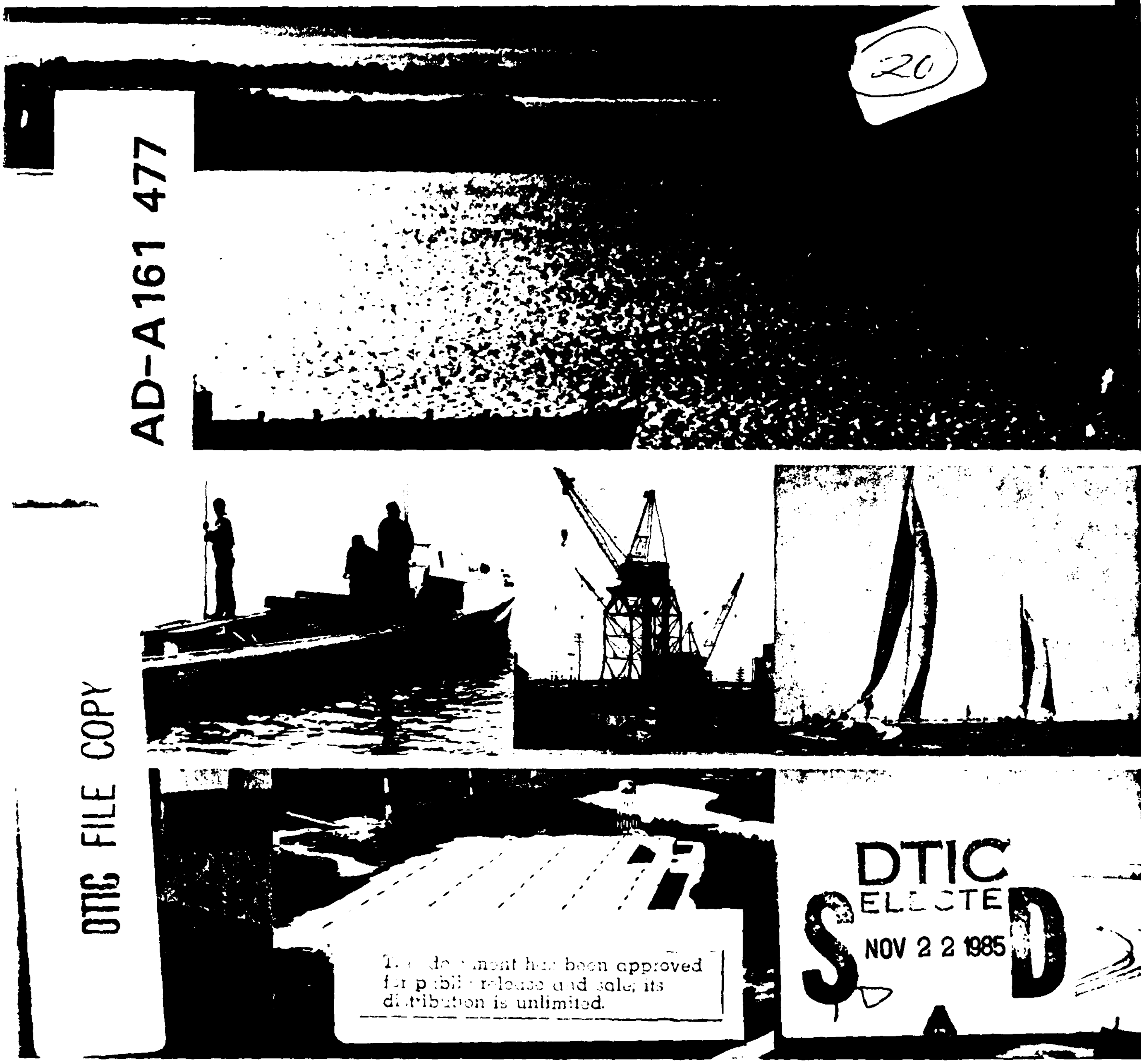

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Periodic tidal flooding is a problem that affects all of the Bay's shoreline. Nearly 60 communities around the Bay were identified as having existing or potential flooding problems. Because of their topography and land use patterns, 12 communities were found to be susceptible to significant monetary losses from tidal flooding.

Both structural and non-structural measures were considered to reduce or prevent the adverse effects of tidal flooding. Structural measures were generally found

20. ABSTRACT

to be very expensive, have adverse environmental effects, and were less acceptable to local residents. Non-structural solutions were usually less expensive and less environmentally damaging. Combinations of the two were found to be the best alternatives for providing tidal flood protection in the Bay area.

Based on the results of the study, it was recommended that survey scope studies be conducted in the Poquoson, Tangier Island, and Hampton Roads areas of Virginia to include the development and verification of a storm surge model capable of forecasting tidal flood stages and developing stage-frequency relationships.

Chesapeake Bay Tidal Flooding Study

(2c)

APPENDIX A - PROBLEM IDENTIFICATION
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US Army Corps of Engineers
Baltimore District

September 1984

CHESAPEAKE BAY

TIDAL FLOODING STUDY

APPENDIX A

PROBLEM IDENTIFICATION

Department of the Army
Baltimore District, Corps of Engineers
Baltimore, Maryland
September 1984

FOREWORD

This is one of the volumes comprising the final report on the Corps of Engineers' Chesapeake Bay Study. The report represents the culmination of many years of study of the Bay and its associated social, economic, and environmental processes and resources. The overall study was done in three distinct developmental phases. A description is provided below of each study phase, followed by a description of the organization of the report.

The initial phase of the overall program involved the inventory and assessment of the existing physical, economic, social, biological, and environmental conditions of the Bay. The results of this effort were published in a seven volume document titled Chesapeake Bay Existing Conditions Report, released in 1973. This was the first publication to present a comprehensive survey of the tidal Chesapeake and its resources as a single entity.

The second phase of the program focused on projection of water resource requirements in the Bay Region for the year 2020. Completed in 1977, the Chesapeake Bay Future Conditions Report documents the results of that work. The 12-volume report contains projections for resource categories such as navigation, recreation, water supply, water quality, and land use. Also presented are assessments of the capacities of the Bay system to meet the identified future requirements, and an identification of problems and conflicts that may occur with unrestrained growth in the future.

In the third and final study phase, two resource problems of particular concern in Chesapeake Bay were addressed in detail: low freshwater inflow and tidal flooding. In the Low Freshwater Inflow Study, results of testing on the Chesapeake Bay Hydraulic Model were used to assess the effects on the Bay of projected future depressed freshwater inflows. Physical and biological changes were quantified and used in assessments of potential social, economic, and environmental impacts. The Tidal Flooding Study included development of preliminary stage-damage relationships and identification of Bay communities in which structural and nonstructural measures could be beneficial.

The final report of the Chesapeake Bay Study is composed of three major elements: (1) Summary, (2) Low Freshwater Inflow Study, and (3) Tidal Flooding Study. The Chesapeake Bay Study Summary Report includes a description of the results, findings, and recommendations of all the above described phases of the Chesapeake Bay Study. It is incorporated in four parts:

Summary Report
Supplement A -- Problem Identification
Supplement B -- Public Involvement
Supplement C -- Hydraulic Model

The Low Freshwater Inflow Study consists of a Main Report and six supporting appendices. The report includes:

Main Report
Appendix A -- Problem Identification
Appendix B -- Plan Formulation
Appendix C -- Hydrology
Appendix D -- Hydraulic Model Test

Appendix E -- Biota
Appendix F -- Map Folio

The Tidal Flooding Study consists similarly of a Main Report and six appendices. The report includes:

Main Report
Appendix A -- Problem Identification
Appendix B -- Plan Formulation, Assessment, and Evaluation
Appendix C -- Recreation and Natural Resources
Appendix D -- Social and Cultural Resources
Appendix E -- Engineering, Design, and Cost Estimates
Appendix F -- Economics

CHESAPEAKE BAY TIDAL FLOODING STUDY

APPENDIX A - PROBLEM IDENTIFICATION

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APPENDIX A

PROBLEM IDENTIFICATION

INTRODUCTION

This Problem Identification appendix to the Tidal Flooding Study Report discusses the several Maryland and Virginia communities which were selected for detailed analyses of tidal flooding problems. Included in this appendix is an overview of the process by which these communities were selected as well as a presentation of previous reports which addressed the tidal flood occurrences. Existing conditions profiles are also provided. It is these profiles which provided the basis for identifying the problems and needs of the several communities as discussed later in this appendix.

STUDY AUTHORITY

The Chesapeake Bay Study and the construction of the Chesapeake Bay Hydraulic Model were authorized by Section 312 of the River and Harbor Act of 1965, adopted on 27 October 1965. This section is as follows:

(a) The Secretary of the Army, acting through the Chief of Engineers, is authorized and directed to make a complete investigation and study of water utilization and control of the Chesapeake Bay Basin, including the waters of the Baltimore Harbor and including, but not limited to, the following: navigation, fisheries, flood control, control of noxious weeds, water pollution, water quality control, beach erosion, and recreation. In order to carry out the purposes of this section, the Secretary, acting through the Chief of Engineers, shall construct, operate, and maintain in the State of Maryland a hydraulic model of the Chesapeake Bay Basin and associated technical center. Such model and center may be utilized, subject to such terms and conditions as the Secretary deems necessary, by any department, agency or instrumentality of the Federal Government or of the States of Maryland, Virginia, and Pennsylvania, in connection with any research, investigation, or study being carried on by them of any aspect of the Chesapeake Bay Basin. The study authorized by this section shall be given priority.

(b) There is authorized to be appropriated not to exceed $6,000,000 to carry out this section.

An additional appropriation for the Study was provided in Section 3 of the River Basin Monetary Authorization Act of 1970, adopted 19 June 1970, which reads as follows:

> In addition to the previous authorization, the completion of the Chesapeake Bay Basin Comprehensive Study, Maryland, Virginia, and Pennsylvania, authorized by the River and Harbor Act of 1965 is hereby authorized at an estimated cost of $9,000,000.

As a result of Tropical Storm Agnes, which caused extensive damage in Chesapeake Bay, the President, on 31 October 1972, signed the Supplemental Appropriation Act of 1973 (Public Law 92-607). This appropriation included $275,000 for additional studies of the impact of Tropical Storm Agnes on Chesapeake Bay.

STUDY PURPOSE AND SCOPE

The Chesapeake Bay Study was a comprehensive investigation to determine the most beneficial use of the Bay's water and related land resources. The expertise required for the conduct of the Chesapeake Bay Study included the fields of engineering and the social, physical, and biological sciences. The study was coordinated with Federal, state and local agencies having an interest in Chesapeake Bay. Each resource category or problem area was treated individually with demands and potential problem areas projected to the year 2020. All conclusions were based on historical information supplied by the agencies having expertise in that field. The geographical study area encompassed those counties or Standard Metropolitan Statistical Areas (SMSA) which adjoin or have a major influence on the Chesapeake Bay Estuary.

The scope of the Tidal Flooding Study was limited to a study of those areas adjacent to Chesapeake Bay and its subestuaries which are subject to tidal flooding induced primarily by h ricanes and northeasters.

The Tidal Flooding Study had three primary objectives. The first objective was to provide a better understanding of the tidal flood stage-frequency relationship in the Bay Region as a whole and also in the communities which are subject to tidal flooding. The second objective was to define the environmental and socio-economic impacts of tidal flooding in those communities subject to flooding. The final objective was to recommend further detailed studies of structural or nonstructural tidal flood protection in those communities where it was found to be economically and environmentally feasible and socially acceptable.

PLANNING OBJECTIVES

The term "planning objectives" refers to the full range of water and related land resource management needs that are specific to each study. They are derived from an analysis of the opportunities, needs, and problems of the study area that can be addressed to enhance the national objectives (i.e., NED and EQ). Planning objectives are intended to provide a meaningful guide and focus for subsequent planning activities. During Stage I of the planning process, the planning objectives were general in scope. Based on the existing and future problems, needs, and opportunities identified during the initial iterations of the planning process, including the preparation of the Chesapeake Bay Existing Conditions and Future Conditions reports, the following were recommended as planning objectives for the expanded Chesapeake Bay Study program:

1. Preserve, restore, and enhance the integrity of the Chesapeake Bay ecosystem.
2. Manage, preserve, and enhance areas of significant natural, historical, cultural, and scientific interest for the inspiration, enjoyment, and education of man.
3. Assure sufficient quantities of water to meet the needs of domestic, municipal, industrial (including power plants), and agricultural users.

4. Assure water of suitable qualities for all intended or potential water resource uses.
5. Maintain, enhance, and/or increase water-based recreational opportunities.
6. Maintain, enhance, and/or increase the commercial and sport fishing opportunities and resources.
7. Maintain or improve water navigation facilities which provide transportation advantageous to the Nation's transportation system.
8. Reduce tidal flooding damages.
9. Reduce damages due to shoreline erosion.
10. Develop power facilities where its provision can contribute to a needed increase in power supply.
11. Control the occurrence of certain aquatic plants where they interfere with man's use of the Bay.
12. Maintain or improve adequate outlets for approved on-farm drainage systems for surface water management.

As it related more directly to the tidal flooding problem, which is the subject of this report, the following were the specific planning objectives for the communities under study.

1. Protect life and property.
2. Reduce flood damages and health hazards due to flooding.
3. Minimize adverse impacts on cultural resources and the natural environment.
4. Minimize adverse impacts on aesthetic values and community cohesion.
5. Avoid inducing any additional flood plain damages.

STUDY PARTICIPANTS AND COORDINATION

Due to the large geographic area comprising the Chesapeake Bay Region and the complex problems which face the estuary, a large number of Federal, state, and local agencies and interstate commissions are involved in various aspects of water resource management in the Region.

The magnitude of the Chesapeake Bay Study, the large number of participants, and the complex spectrum of problems to be analyzed required intensive coordination of activities. The initial planning of this study was coordinated with the then National Council of Marine Resources and Engineering Development through its Committee on Multiple Use of the Coastal Zone. This study was conceived as a coordinated partnership between Federal, state, and local agencies and interested scientific institutions. Each involved agency was charged with exercising leadership in those disciplines in which it had special competence and reviewed and commented on work performed by others. To realize these ends, an Advisory Group, a Steering Committee, and two Task Groups (Tidal Flooding and Freshwater Inflow), were established. The overall management of the Chesapeake Bay Study was the responsiblity of the District Engineer of the Baltimore District, Corps of Engineers.

The Advisory Group, established in 1967, was the principal coordinating mechanism for the Study. Since its establishment, the Advisory Group advised the District Engineer regarding study policy and provided general direction under which all study participants

operated. The Steering Committee for Liaison and Basic Research was charged with reviewing the work of the other study task groups in order to bring to their attention and to the attention of the District Engineer any pertinent technological advances in water resources development or the environmental sciences that may not be explicit in the tasks assigned to these groups. The two task groups were established along study lines with the Tidal Flooding Task Group providing the primary input to the Tidal Flooding Study. The state and Federal agencies represented on the Task Group are shown in Table A-1.

TABLE A-1

TIDAL FLOODING TASK GROUP MEMBERSHIP

Corps of Engineers	Environmental Protection Agency
Department of Agriculture	Department of the Interior
Department of Transportation	State of Maryland
Federal Emergency Management Agency	Commonwealth of Virginia
Department of Commerce	District of Columbia

In addition to the Federal and state coordination outlined above, the study was also coordinated with local officials in those communities selected for detailed study. This local coordination included meeting with elected officials at both the county and the community level and also meeting and exchanging data with public works and planning officials of each community.

SELECTION OF COMMUNITIES FOR STUDY

During the Future Conditions phase of the Chesapeake Bay Study, flood problem areas were identified by considering the degree of tidal flooding to be experienced by those communities located along the shoreline of the Bay and its tributaries. The number of areas initially considered were reduced through several screening efforts which are described below. Additional screenings were also conducted as part of the Revised Plan of Study and during the development of intermediate plans.

FUTURE CONDITIONS REPORT

The first step of the initial screening was to identify all communities or urban areas having a population of 1,000 or greater located either totally or in part within the Standard Project Tidal Flood (SPTF) Plain. The SPTF is defined as the largest tidal flood that is likely to occur under the most severe combination of meteorological and hydrological conditions that are considered reasonably characteristic of the geographic region. The Corps of Engineers in cooperation with the U.S. Weather Bureau (now the National Weather Service) determined that for the Chespeake Bay Region the SPTF would average approximately 13 feet above National Geodetic Vertical Datum (NGVD). This figure is a static or standing water surface elevation which would occur in conjunction with an astronomical high tide and does not include the effects of waves. Superimposing waves characteristic of a hurricane that would produce a tidal surge of 13 feet (NGVD), wave heights of approximately 5 feet could be expected. Based on the above combination of tidal surge and wave action the SPTF would inundate areas up to

approximately 18 feet (NGVD). However, for ease in delineating the flood area on the best available topography, an elevation of 20 feet (NGVD) was assumed for the SPTF elevation. While an elevation of 20 feet was considered conservative, it was appropriate for the initial screening of possible flood-prone communities.

The next step in the initial screening was to identify those communities that should be classified as "flood-prone." For a community to be designated as flood-prone, at least 50 acres of land that were developed for intensive use had to be inundated by the SPTF. Intensive land use was defined as residential (four dwelling units/acre or greater), commercial (including institutional), or industrial development. The 60 Bay Region communities identified as flood-prone are listed in Table A-2. Approximately 82,000 acres of land in these communities were found to be located in the standard project tidal flood plain.

The last step in the initial screening process was to determine those communities considered to be "critically" flood-prone. The flood problem was considered to be "critical" if 25 acres or more of intensively developed land were inundated by the 100-year flood. The communities found to be "critical" based on this criterion are marked with an asterisk in Table A-2. It should be noted that the elevations used for the 100-year flood were approximated based on the best available historical information.

REVISED PLAN OF STUDY

During the preparation of the Revised Plan of Study, a further screening of those critical communities listed in Table A-2 was conducted. This screening eliminated those critical communities where it was evident that flood protection would not be acceptable to the community. This determination was based on the fact that many strictly residential critical communities are located along the Bay's shoreline for aesthetic as well as recreational reasons, and a structural solution would require, in most cases, a floodwall of excessive height. This type of structure would impact upon the use of the shoreline for recreation and would cause visual disruption of the shoreline. In these communities, the expressed concern was related to the erosion of land that takes place during tidal storms, instead of the damages that result from temporary inundation of house and property. Application of nonstructural solutions in these same areas, such as floodproofing and relocation, was also inappropriate. Many of the structures were old and not suitable for major floodproofing modifications and, as previously mentioned, these areas were established adjacent to the shoreline to take advantage of the resource, thus making relocation unacceptable.

Based on the above considerations, the communities recommended for detailed study in the Revised Plan of Study were limited to those listed in Table A-3. All the recommended communities were considered to have highly developed flood-prone areas where the potential existed for providing some form of flood protection. The Revised Plan of Study further recommended that the second stage of the planning process concentrate on refinement of environmental, economic, social and hydrologic data and the formulation and evaluation of various flood damage reduction measures.

TABLE A-2

FLOOD-PRONE AND CRITICALLY FLOOD-PRONE COMMUNITIES

STATE OF MARYLAND

Anne Arundel County
*Arundel on the Bay
*Avalon Shores (Shady Side, Curtis Pt. to Horeshoe Pt. and West Shady Side)
Broadwater
Columbia Beach
*Deale
Eastport
Franklin Manor on the Bay and Cape Anne
Galesville
Rose Haven

*Baltimore City

Baltimore County
Back River Neck
*Dundalk (Including Sparrows Pt.)
*Middle River Neck
*Patapsco River Neck

Calvert County
Cove Point
North Beach on the Bay
Solomons Island

Caroline County
Choptank
*Denton
Federalsburg

Cecil County
Elkton
Northeast

Charles County
Cobb Island

Dorchester County
*Cambridge

Harford County
Havre de Grace

Kent County
*Rock Hall

Queen Anne's County
Dominion
*Grasonville
Stevensville

St. Mary's County
Colton
*Piney Point
St. Clement Shores
St. George Island

Somerset County
*Crisfield
*Smith Island

Talbot County
Easton
Oxford
*St. Michaels
*Tilghman Island

Wicomico County
Bivalve
Nanticoke
*Salisbury

Worcester County
*Pocomoke City
*Snow Hill

COMMONWEALTH OF VIRGINIA

Independent Cities
*Chesapeake
*Fredericksburg
*Hampton
Newport News
*Norfolk
*Portsmouth
*Virginia Beach

Accomack County
Onancock
Saxis
*Tangier Island

King George County
*Dahlgren

King William County
*West Point

Northampton County
*Cape Charles

Westmoreland County
*Colonial Beach

York County
*Poquoson

*WASHINGTON, D.C.

*Indicates Critically Flood-Prone Community

TABLE A-3

CRITICAL COMMUNITIES RECOMMENDED FOR DETAILED STUDY

STATE OF MARYLAND

Baltimore County	Somerset County
Dundalk (including Sparrows Pt.)*	Crisfield
	Smith Island*
Baltimore City*	Talbot County
	St. Michaels
Caroline County	Tilghman Island
Denton*	
	Wicomico County
Dorchester County	Salisbury*
Cambridge	
	Worcester County
Kent County	Pocomoke City
Rock Hall	Snow Hill

COMMONWEALTH OF VIRGINIA

Independent Cities**	King William County
Chesapeake	West Point
Fredericksburg*	
Hampton	Northampton County
Norfolk	Cape Charles
Portsmouth	
	Westmoreland County
Accomack County	Colonial Beach*
Tangier Island	
	York County
	Poquoson

*These communities were recommended for detailed study but initial examinations determined that detailed analysis was inappropriate (see text).

**The Cities of Chesapeake, Hampton, Norfolk, and Portsmouth are collectively referred to as the Hampton Roads complex.

With the approval of the Revised Plan of Study, Stage II studies were undertaken for the communities listed in Table A-3. Early in Stage II several additional communities were eliminated from further consideration. Smith Island, Maryland, Colonial Beach, Virginia, and Virginia Beach, Virginia were eliminated as detailed studies of these communities were being conducted under specific study resolutions and further effort under the Chesapeake Bay Study would have been duplicative. Denton and Salisbury, Maryland, were both eliminated when preliminary stage-damage surveys and detailed mapping and flood plain delineation indicated that the flood problem was limited to only scattered development at frequencies in excess of once in 100 years. Likewise, Fredericksburg, Virginia, was eliminated when fluvial rather than tidal flooding was found to be the problem.

Last and most significantly, Baltimore City and the Dundalk area of Baltimore County were also eliminated after preliminary damage surveys and evaluations of several structural and nonstructural measures. These preliminary evaluations indicated that structural and nonstructural measures that would provide flood protection for the most flood-prone sections of these two areas would have benefit-cost ratios on the order of only 0.1. These evaluations confirmed the findings of the Baltimore District's Baltimore Metropolitan Flood Study.

Thus those communities listed in Table A-3 less Smith Island, Colonial Beach, Denton, Salisbury, Fredericksburg, Dundalk and Baltimore City were evaluated in detail. The results of those studies are presented in subsequent portions of this report. The general location of the 12 communities selected for detailed study is indicated in Figure A-1.

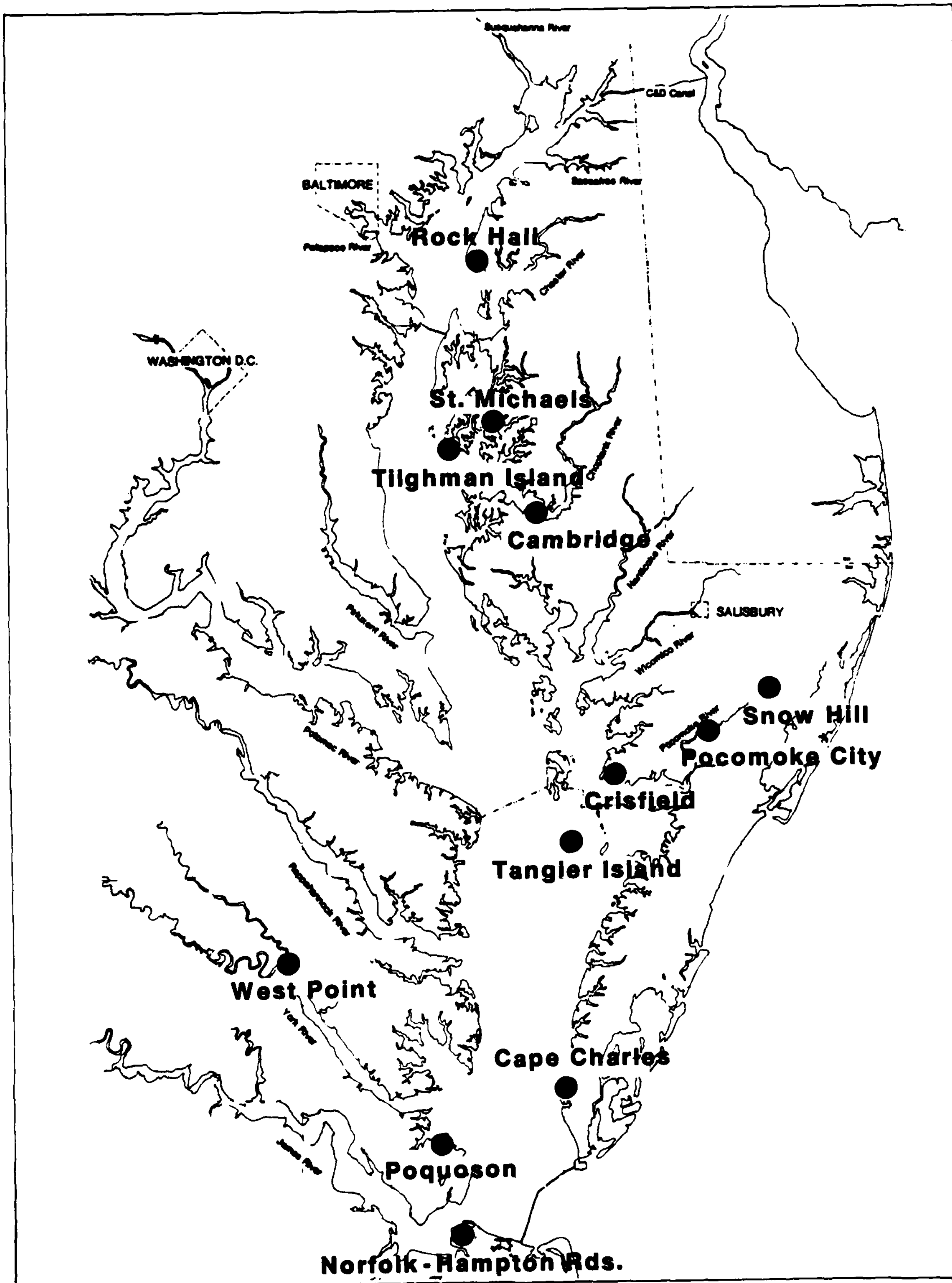


FIGURE A-1 LOCATION OF CRITICAL FLOOD-PRONE COMMUNITIES

PRIOR STUDIES AND REPORTS

While there have been a limited number of tidal flooding-related studies that have investigated specific communities around the Chesapeake Bay, there has been only one comprehensive Bay-wide tidal flooding study conducted by the Corps in the last two decades. The authorization for this study, contained in Public Law 71, 84th Congress, 1st Session, approved 15 June 1955, was as follows.

> Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled: That in view of the severe damage to the coastal and tidal areas of the eastern and southern United States from the occurrence of hurricanes, particularly the hurricanes of August 31, 1954 and September 11, 1954, in New England, New York and New Jersey coastal and tidal areas, and the hurricane of October 15, 1954 in the coastal and tidal areas extending south to South Carolina, and in view of the damages caused by the other hurricanes in the past, the Secretary of the Army, in cooperation with the Secretary of Commerce and other Federal agencies concerned with hurricanes is hereby authorized and directed to cause an examination and survey to be made of the eastern and southern seaboard of the United States with respect to hurricanes with particular reference to areas where severe damages have occurred.
>
> SEC. 2. Such survey, to be made under the direction of the Chief of Engineers, shall include the securing of data on the behavior and frequency of hurricanes, and the determination of methods of forecasting their paths and improving warning services, and of possible means of preventing loss of human lives and damages to property, with due consideration of the economics of proposed breakwaters, seawalls, dikes, dams and other structures, warning services or other measures which might be required.

This authorization resulted in several studies and subsequent reports which addressed various segments of the tidal shoreline. Specific reports were prepared that considered (1) the Baltimore, Maryland Metropolitan Area, (2) the Washington, D.C. Metropolitan Area, (3) Colonial Beach, Virginia, (4) Garden Creek, Mathews County, Virginia, (5) the tidewater portions of the Patuxent, Potomac and Rappahannock Rivers, including the adjacent Chesapeake Bay shoreline, and (6) the entire tidal shoreline of the Eastern Shore of Maryland and Virginia and the Western Shore of Maryland from the head of the Bay to the mouth of the Patuxent River.

No recommendations for construction of any hurricane protective works resulted from any of the above studies. The following conclusions and recommendations quoted from House Document No. 176, Eighty-eighth Congress, 1st session, 25 November 1963, Chesapeake Bay, Maryland and Virginia, are considered typical of the findings of these earlier studies.

On the Eastern shore of the Chesapeake Bay there were no locations at which local interests specifically requested construction of protective structures to prevent tidal flooding. Investigation of the shore showed that there were no locations at which construction of protective structures could be justified although there exist in Dorchester and Somerset Counties large areas that would be flooded by hurricane-induced tides of 10 feet or greater. In these areas serious consideration should be given by local authorities to developing an adequate evacuation plan.

On the Western shore of the Chesapeake Bay there were found no locations at which extensive flooding would occur from high tides since elevations of 20 feet or more exist at short distances from the new high water shoreline. At some locations along the shore local interests requested protection from beach erosion. In these locations, it was found that local interests did not desire protection from hurricane-induced tides and since investigations to provide beach erosion protection can be accomplished under existing laws, provision of protection was not investigated for these areas.

Since there appear to be no locations on the east or west shore of the Chesapeake Bay at which protection from hurricane-induced tides could be justified the District Engineer recommends that no further planning or investigation for the provision of hurricane protective works within the study area be undertaken at this time. The District Engineer recommends, however, that this report be published and distributed to appropriate officials in the area who may find the information contained therein of use in the establishment of flood plain regulatory measures and evacuation procedures.

Given this overview relative to past Bay-wide studies the following paragraphs address prior water resource-related studies conducted in those communities which were selected for detailed study.

CAMBRIDGE, MARYLAND

Prior studies and reports for Cambridge have all been in the interest of navigation dating back as early as 1871. These reports and the initiating authorizations are discussed below.

a. The River and Harbor Act of 11 July 1870, authorized an examination of the channel area. The report which was favorable toward a channel 10 feet deep and 100 feet wide is found in the 1871 Annual Report of the Chief of Engineers.

b. The River and Harbor Act of 5 August 1886, authorized a preliminary examination and survey of the Cambridge Channel. The reports were favorable to channel improvement to 12 feet deep to the railroad wharf, 10 feet deep to the drawbridge and 8 feet deep to the head of wharfage with a continuous width of 150 feet. This recommendation is found in the Annual Report to the Chief of Engineers.

c. The River and Harbor Act of 3 June 1896, authorized a preliminary examination and survey of the Cambridge Harbor area. The reports were favorable and recommended a channel 12 feet deep, 150 feet wide to a point 500 feet outside the Baltimore,

Chesapeake and Atlantic Railroad Company's steamboat wharf, and from this point gradually widening to the harbor line at the wharf, to increase the width an average of 200 feet with a depth of 8 feet, making an anchorage basin; increasing the width of the lower harbor 40 feet on the north side and widening the upper harbor an average of 360 feet along the channel already dredged, to a depth of 8 feet. These reports are printed in House Document No. 119, Fifty-Fourth Congress, 2nd session.

d. The River and Harbor Act of 3 March 1909, authorized a survey and preliminary examination of the outer channel area. The reports were favorable to modifying the existing project by straightening the outer channel giving the channel a minimum width of 270 feet. The reports were unfavorable to widening and deepening the inner channel from 8 feet to 10 feet. These reports are found in House Document No. 560, Sixty-first Congress, 2nd session. The modification contained in this report was not adopted.

e. The River and Harbor Act of 22 September 1922, authorized a survey and preliminary examination of the Cambridge area turning basin. The reports were favorable to a channel 12 feet deep, 150 feet wide to the drawbridge; and 10 feet deep, 100 feet wide from the bridge to the upper end of the harbor, with a turning basin 200 feet square at that point. The reports are printed in House Document No. 210, Sixty-eighth Congress, 1st session.

f. The Rivers and Harbors Committee Resolution of 31 July 1935, authorized a survey and preliminary examination of the Cambridge Harbor channels and anchorage areas. The reports were favorable to a channel 14 feet deep, 150 feet wide to the Market Street Bridge, 100 feet wide above the bridge with a turning basin of the same depth at the head of the channel; for an anchorage basin 10 feet deep, 400 feet long and 175 feet wide on the west side of the channel, and a second basin of the same depth, 225 feet long and 200 feet wide on the east side of the channel; and a channel 60 feet wide and 7 feet deep from that depth in Choptank River to the municipal boat basin. The reports are found in the Rivers and Harbors Committee Document No. 7, Seventy-fifth Congress, 1st session.

g. The Rivers and Harbors Committee Resolution of 28 February 1939, authorized a survey and preliminary examination of Choptank River Channel. The report, which was not printed, was unfavorable to a channel 18 feet deep from the Choptank River to the head of the harbor.

h. The River and Harbor Act of 2 March 1945, authorized a survey and preliminary examination of the channel in the area of Cambridge Creek. The report was favorable to a channel 16 feet deep at mean low water and 150 feet wide from the 16-foot depth curve in Choptank River to the Market Street bridge over Cambridge Creek, thence 16 feet deep and 100 feet wide to the head of the harbor, with a turning basin of the same depth and or irregular dimensions, comprising approximately 2.4 acres. The report was printed in House Document No. 381, Eightieth Congress, 1st session.

i. By means of a Resolution of the Committee on Public Works of the House of Representatives adopted 3 September 1964, 2 December 1970, and 14 June 1972, a survey and preliminary examination of the existing Federal project was authorized. The report recommended that the exsiting Federal project for Cambridge be modified to provide for Federal maintenance of the non-Federally constructed 25-foot deep navigation project. This report is found in the Survey Report on Cambridge Harbor dated 5 April 1976.

CRISFIELD, MARYLAND

Prior reports for Crisfield have all been in the interest of navigation and are as follows:

a. The River and Harbor Act of 23 June 1874, authorized a preliminary examination and survey of Crisfield Harbor. The reports, which were favorable to improvement, are printed in the 1875 Annual Report of the Chief of Engineers.

b. The River and Harbor Act of 3 March 1905, authorized a preliminary examination and survey of Crisfield Harbor. The reports, which are printed in House Document No. 783, Fifty-ninth Congress, 1st session, were favorable to the provision of an anchorage basin on the west side of the channel.

c. The River and Harbor Act of 2 March 1919, authorized a preliminary examination of Crisfield Harbor. The reports, which are printed in House Document No. 276, Sixty-sixth Congress, 1st session, were unfavorable to increasing the project depth to 25 feet and to dredging a channel in Somers Cove.

d. The River and Harbor Act of 22 September 1922, authorized a preliminary examination and survey of Crisfield Harbor. The reports which form the basis of the existing project, are printed in House Document No. 355, Sixty-eighth Congress, 1st session.

e. The Committee on Rivers and Harbors of the House of Representatives, by resolution adopted 27 February 1934, authorized review of the reports described in the preceding paragraph. The reports on the review were favorable to the provision of a channel 7 feet deep and 100 feet wide from the head of the 10-foot channel opposite Hop Point eastward 1,300 feet to an anchorage basin 7 feet deep, 160 feet wide, and 1,200 feet long roughly parallel to Brick Kiln Road. The reports are printed in Rivers and Harbors Committee Document No. 2, Seventy-fifth Congress, 1st session.

f. The River and Harbor Act of 30 August 1935, authorized a preliminary examination and survey of a "waterway from Little Annemessex River to Tangier Sound, MD., by way of Cedar Creek, a land cut, and Flat Cap Creek." The reports, which are printed in House Document No. 72, Seventy-fifth Congress, 1st session, were favorable to a modification of the project for Crisfield Harbor to provide for the above waterway by way of Dougherty Creek instead of Flat Cap Creek.

g. The Committee on Rivers and Harbors of the House of Representatives, by resolution adopted 23 February 1938, authorized a review of the reports contained in Rivers and Harbors Committee Document No. 2, Seventy-fifth Congress, 1st session, and previous reports, with a view to determining the advisability of modifying the existing project. The reports, which are printed in House Document No. 457, Seventy-sixth Congress, 1st session, were favorable to a modification of the project for Crisfield Harbor to provide for a mooring basin 7 feet deep, 160 feet wide, approximately 875 feet long roughly parallel to Brick Kiln Road, with a channel 7 feet deep and 100 feet wide leading therefrom to the 7-foot project channel connecting Little Annemessex and Big Annemessex Rivers, instead of the previously authorized anchorage basin and access channel described above.

h. The River and Harbor Act approved 2 March 1945, authorized a preliminary examination and survey of Crisfield Harbor. The report printed as House Document No. 435, Eighty-first Congress, 2nd session, recommended that the existing project be modified to provide a 10-foot deep anchorage basin in Somers Cove with a 10-foot deep approach channel from that depth in the Little Annemessex River.

POCOMOKE CITY AND SNOW HILL, MARYLAND

Prior studies and reports for the Pocomoke City and Snow Hill area have been limited to the following navigation studies of the Pocomoke River.

a. The River and Harbor Act of 17 August 1894, authorized a preliminary examination and survey of "Pocomoke River, MD., with a view to uniting the waters of said river with the waters of Sinepuxent Bay at a point above Snow Hill and of improving said river between Shad Landing and Snow Hill." The reports which are printed in the 1895 Annual Report of the Chief of Engineers, were favorable only to an improvement between Shad Landing and Snow Hill and form the basis for the upper portion of the existing project.

b. The River and Harbor Act of 25 July 1912, authorized a preliminary examination and survey, and the reports, printed in House Document No. 1165, Sixty-fourth Congress, 1st session, were favorable to providing a channel 100 feet wide and 7 feet deep at mean low water from the mouth of the river to Shelltown, thence 9 feet at mean low water at Snow Hill. The project was not adopted by Congress.

c. The River and Harbor Act of 3 July 1930, authorized a preliminary examination and survey of the area at the mouth of the river known as The Muds. The reports, printed in House Document No. 227, Seventy-fourth Congress, 1st session, were favorable to providing a channel 100 feet wide and 7 feet deep at mean low water from the 7-foot contour in Pocomoke River through the base of Williams Point to the 7-foot contour in Pocomoke Sound, subject to certain conditions of local cooperation, and form the basis for the existing project at the mouth of the Pocomoke River, known as The Muds.

d. The River and Harbor Act of 26 August 1937, authorized a preliminary examination of "Pocomoke River from a point above Snow Hill to deep water in Pocomoke Sound." The reports were unfavorable and were not printed.

e. The Committee on Rivers and Harbors of the House of Representatives, United States, by resolution adpoted 21 October 1938, authorized a review of reports on Pocomoke River in House Document No. 1165, Sixty-fourth Congress, 1st session, and previous reports. The review reports were favorable to the extension of Document No. 429, Seventy-sixth Congress, 1st session.

f. The River and Harbor Act approved 2 March 1945 authorized a preliminary examination and survey which resulted in a recommendation that the existing project be modified to provide a channel 11 feet deep from the 11-foot depth curve in the Pocomoke River to Tulls Point. The project was subsequently authorized, but never constructed.

ROCK HALL, MARYLAND

Prior reports were in the interest of navigation improvements for Rock Hall Harbor. A summary of these reports follows.

a. The River and Harbor Act of 19 September 1890, provided for a preliminary examination of Rock Hall Harbor. It called for a channel 10 feet deep by 100 feet wide and 5,650 feet long, and a channel with the same width and depth one mile across Swan Point Bar. The project was authorized by the River and Harbor Act of 3 June 1896, and was completed on 14 June 1898. The channel across Swan Point Bar was dredged to only 60 feet wide.

b. The River and Harbor Act of 3 March 1899, called for a reexamination of the project. The report provided for widening and deepening of the channels to 150 feet and 12 feet, respectively.

c. The River and Harbor Act of 4 March 1913, authorized the channel improvements contained in the previous report (R&H 1899). Channel depths were dredged to 10 feet instead of 12 feet. The project was never completed due to heavy shoaling and was abandoned in August 1914.

d. A report dated 25 August 1913, and printed in House Document No. 207, Sixty-third Congress, 1st session, from the Chief of Engineers, presented the results of a preliminary study for extending navigation channels. An extension of the inner channel into a small inlet southeast of the upper end of the inner harbor by the dredging of a channel 8 feet deep and 60 feet wide with an anchorage basin 200 feet by 300 feet was proposed to secure additional anchorage area. The project was turned down due to the abandonment of the main channels.

e. A report dated 4 December 1915, and printed in House Document No. 57, Sixty-fourth Congress, 1st session, from the Chief of Engineers, reexamined the 1913 proposals and concluded the project still was unacceptable.

f. A report dated 2 April 1937, printed in House Document No. 204, Seventy-fifth Congress, 1st session, from the Chief of Engineers, approved a plan to improve the harbor. It called for a channel 60 feet wide and 7 feet deep from the inlet to the harbor frontage, a channel of similar depth and width paralleling the frontage for a distance of 700 feet, an anchorage 800 feet long, 100 feet wide, and 7 feet deep by the northwest extension of the channel, and small stone breakwaters 1,590 feet in total length. Also, a 500-foot long bulkhead on the north edge of the basin was considered. This project was completed in 1939.

g. A report dated 11 March 1947, printed in House Document No. 273, Eightieth Congress, 1st session, from the Chief of Engineers, approved an enlargement of the harbor channels. It provided for enlarging the entrance channel and channel parallel to the harbor terminals to a width of 100 feet and a depth of 10 feet, deepening the easterly 250 feet of the project anchorage basin to 3 feet, and excavating a basin 200 feet wide, and 8 feet deep for a distance of 600 feet in a southwest direction from the west end of the anchorage. The project was completed in 1957.

h. A reconnaissance report for addtional navigation improvements was completed in October 1972 and was the basis for a feasibility report completed in December 1978. The feasibility report recommended that the existing breakwaters be raised and extended to provide additional wave protection.

ST. MICHAELS, MARYLAND

Under the authority of Section 107 of the River and Harbor Act of July 1960, a Detailed Project Report in the interest of navigation was completed in December 1961. The report recommended that a channel 6 feet deep and 50 feet wide be provided from the 6-foot depth curve in the inner harbor to and including a 100-foot wide and 200-foot long basin of the same depth. The project was subsequently authorized and constructed in 1964.

TILGHMAN ISLAND, MARYLAND

All prior studies and reports pertaining to Tilghman Island were in the interest of navigation and are listed as follows:

a. Studies authorized by the River and Harbor Act of 25 June 1910, printed in House Document No. 400, Sixty-second Congress, 2nd session, were favorable to provision of an anchorage basin 300 feet wide, 700 feet long and 10 feet deep. The improvements were authorized by the River and Harbor Act of 25 July 1912, but were not constructed as they did not meet the desires of local interests.

b. Review of the authorized project with a view towards modification was authorized by the River and Harbor Act of 4 March 1913. The results of the studies, published as House Document No. 796, Sixty-third Congress, 2nd session, recommended provision of an anchorage basin 8 feet deep of irregular shape about 400 feet by 400 feet. These improvements were authorized by the River and Harbor Act of 2 March 1919. As potential commerce was not believed to be sufficient to justify provision of the project, construction was not initiated, and in 1926 the project was recommended for abandonment (House Document No. 467, Sixty-ninth Congress, 2nd session).

c. In response to a 15 August 1961 resolution by the Committee on Public Works of the House of Representatives to review past reports on Tilghman Island Harbor, a report was completed in August 1965. The study found that provision of a channel 60 feet wide and 6 feet deep and including two anchorage basins, 300 feet long by 70 feet wide and 500 feet long by an average width of 110 feet was justified and advisable. These improvements were authorized on 13 May 1966 under Section 107 of the River and Harbor Act of 1960 and serve as the basis for the existing project. At the request of local interests, the project was modified to provide a single anchorage basin of irregular shape about 500 feet long and 200 feet wide. The project was constructed in 1971.

d. Under the authority of Section 107 of the River and Harbor Act of 1960, as amended, a study to determine the feasibility of providing improvements to the existing Tilghman Island Harbor navigation project was undertaken and completed in 1980. The project was authorized for construction by the Chief of Engineers under Section 107 on 20 October 1980. Construction of a small breakwater began in April 1982 and was completed in December 1982.

CAPE CHARLES, VIRGINIA

Several reports have been submitted to the Congress by the Corps for the improvement of the harbor adjoining Cape Charles to the south. As a result, Cape Charles Harbor has been dredged to a depth of 18 feet, Mud Creek Channel to a depth of 10 feet, and the adjoining harbor of refuge to a depth of 7 feet.

A report dated 31 May 1961, on a hurricane survey of the Eastern Shore of Virginia was submitted in compliance with Public Law 71, Eighty-fourth Congress, 1st session. Cape Charles was included in this survey. The report recommended that Federal improvements for hurricane protection for the Eastern Shore of Virginia not be undertaken.

A flood pla' . information report dated May 1970 was prepared by the Corps and submitte' to the town. It indicated the high water situation and the potential for future flooding. A flood insurance study to account for the effect of wave action was prepared by Dewberry and Davis and became effective on 2 February 1983. A shoreline situation report on Northampton County was published by the Virginia Institute of Marine Science in 1974.

A national shoreline study was prepared by the Chief of Engineers on 4 May 1973 and included in House Document 93-121, Ninety-third Congress, 1st session. It encompassed shoreline erosion data along the coastal regions of the United States.

A flood insurance study dated July 1975 was prepared by the Corps for Northampton County and submitted to the Flood Insurance Administration.

The State Water Control Board prepared a report entitled "Small Coastal River Basins and Chesapeake Bay, Virginia, Eastern Shore Portion, Comprehensive Water Resources Plan, Volume V-A Water Quality Management Plan, Planning Bulletin 253 A, June 1976."

"A Process for the Review and Evaluation of the Management of Virginia's Coastal Resources" was prepared by the Office of the Secretary of Commerce and Resources and adopted in December 1980.

"Storm Surge Height-Frequency Analysis and Model Prediction for Chesapeake Bay, Special Report No. 189," dated June 1978, was prepared by the Virginia Institute of Marine Science. This report was to be used by the Federal Insurance Administration.

A 1979 report of the President's Council on Environmental Quality called national attention to conditions in Chesapeake Bay.

"Eastern Shore of Virginia Resource Conservation and Development Project Plan," was published in December 1975 and prepared by the Eastern Shore of Virginia Resource Conservation and Development project sponsors which included the Accomack County and Northampton County Boards of Supervisors, the Eastern Shore Soil and Water Conservation District and the Accomack - Northampton Planning District Commission #22, assisted by the U.S. Department of Agriculture and other cooperating agencies.

"The Northampton County Background Study, January 1975" and the Brown and Root Impact Study, February 1975" were prepared by Urban Pathfinders, Inc., Baltimore, Maryland for the Northampton County Planning Commission in connection with an

evaluation of the Brown and Root proposal to fabricate large metal structures including off-shore oil and gas platforms and other related equipment on a 980-acre site in Cape Charles.

HAMPTON ROADS, VIRGINIA

A report entitled "Norfolk, Virginia" was prepared by the Corps in response to Public Law 71, Eighty-fourth Congress, 1st session. It was published in House Document 354, Eighty-seventh Congress, 2nd session, dated 6 October 1961. In this report, the Chief of Engineers recommended improvements for the prevention of hurricane tidal damage in the Norfolk central business district.

A report entitled "Interim Report on Hurricane Survey - South Shore of Chesapeake Bay from Hampton Roads to Little Creek" was prepared by the Corps in response to Public Law 71, Eighty-fourth Congress, 1st session. It was published in House Document 215, Eighty-eighth Congress, 2nd session, dated 29 November 1963. In this report, the Chief of Engineers recommended that Federal improvements for hurricane protection, other than those authorized for the central business district of Norfolk by the Flood Control Act of 1962, and for the South Shore of Chesapeake Bay from Hampton Roads to Little Creek, Virginia, not be undertaken at this time.

An interim report entitled "Middle and Lower Peninsulas of Virginia" was prepared by the Corps in response to Public Law 71, Eighty-fourth Congress, 1st session. It was published in House Document No. 288, Eighty-eighth Congress, 2nd session, dated 26 March 1964. It does state that many buildings and residences have been constructed on the wide lowlands adjacent to the coast, where the elevation is below 10 feet NGVD. The Chief of Engineers recommended that Federal improvement for tidal flood protection not be undertaken.

Hampton Roads Water Quality Plan dated 31 May 1978, was prepared by the Hampton Roads Water Quality Agency. Flood plain information reports were prepared for Virginia Beach, Norfolk, Chesapeake, Portsmouth, and Hampton in the early 1970's. Flood insurance studies were completed in the late 1970's for these communities. Wave height studies have been prepared for Virginia Beach, Norfolk, Portsmouth, and Hampton.

"A Process for the Review and Evaluation of the Management of Virginia's Coastal Resources, December 1980" was prepared by the Office of the Secretary of Commerce and Resources. The report provides information on the prudent management and preservation of the coastal land and water resources in Virginia.

POQUOSON, VIRGINIA

An interim report entitled "Middle and Lower Peninsulas of Virginia" was prepared by the Corps in response to Public Law 71, Eighty-fourth Congress, 1st session. It was published in House Document No. 288, Eighty-eighth Congress, 2nd session, dated 26 March 1964. In this report, a preliminary plan was considered for protecting Poquoson against a tidal stage of elevation 10, or about 2 feet above the height of the August 1933 hurricane or 3.6 feet above the level of the northeaster in 1962. The proposed dikes and/or walls would have had to encircle practically the entire community and would have varied in height from 0 to 12 feet above the ground. Protection would have been provided for about 3,100 acres of land. Four pumping stations would have been required and roads would have been ramped over the dike to eliminate the necessity for closures. The plan

would have included adjustments to interior drainage facilities made necessary by construction of the dike and pumping stations. A rough estimate of the cost was $3.9 million and the benefit-cost ratio was 0.3. Construction of levees and appurtenant works for any portion of the area considered in the above plan was not believed to be economically justified.

A National Shoreline Study was prepared by the Chief of Engineers on 4 May 1973 and included in House Document 93-121, Ninety-third Congress, 1st session. It encompassed shoreline erosion data along the coastal regions of the United States.

"A Shoreline Situation Report" and "Tidal Marsh Inventory" were prepared by the Virginia Institute of Marine Science in August 1974.

"A Comprehensive Plan—City of Poquoson, Virginia, 1975," was prepared by the Poquoson City Planning Commission.

A flood plain information report on the extent of coastal flooding in Poquoson was prepared by the Corps in June 1971. A flood insurance study was prepared for the Federal Insurance Administration in November 1976. This study only took stillwater into account in the determination of flood heights. A revised flood insurance study, taking into account wave action was published by the FIA in August 1983.

"A Process for the Review and Evaluation of the Management of Virginia's Coastal Resources" was prepared by the Office of the Secretary of Commerce and Resources and adopted in December 1980.

"Hampton Roads Water Quality Management Plan, June 1978" was prepared by the Hampton Roads Water Quality Agency. It encompassed Virginia Planning Districts 20 and 21.

"Storm Surge Height-Frequency Analysis and Model Prediction for Chesapeake Bay, Special Report No. 189," dated June 1978, was prepared by the Virginia Institute of Marine Science. This report was prepared for the Federal Insurance Administration.

TANGIER ISLAND, VIRGINIA

Several reports have been submitted to the Congress by the Corps of Engineers for the construction of a channel and anchorage basin on the north side of the inhabited portion of the island. As a result, channels 7 and 8 feet in depth connect the island with Tangier Sound to the east and Chesapeake Bay to the west.

A Shoreline Situation report was prepared by the Virginia Institute of Marine Science in 1974.

The State Water Control Board prepared a report entitled "Small Coastal River Basins and Chesapeake Bay, Virginia Eastern Shore Portion, Comprehensive Water Resources Plan, Volume V-A Water Quality Management Plan, Planning Bulletin 253 A, June 1976."

"Report on 201 Facilities Plan for Tangier Island" was prepared by Shore Engineering Company in 1976 for the State Water Control Board.

"Storm Surge Height-Frequency Analysis and Model Prediction for Chesapeake Bay: Special Report No. 189," dated June 1978, was prepared by the Virginia Institute of Marine Science. This report was prepared for the Federal Insurance Administration.

A flood insurance study taking into account the effect of wave action was published in October 1982 by the Federal Insurance Administration.

WEST POINT, VIRGINIA

Several reports have been submitted to the Congress by the Corps for improvement of the channel in York River. As a result, there is a channel 22 feet deep from the mouth to West Point.

An interim report entitled "Middle and Lower Peninsula of Virginia" was prepared by the Corps in response to Public Law 71, Eighty-fourth Congress, 1st session. It was published in House Document No. 288, Eighty-eighth Congress, 2nd session, dated 26 March 1964. No mention of a serious tidal problem is made in this report. It does state that many buildings and residences have been constructed on the wide lowlands adjacent to the coast, where the elevation is below 10 feet NGVD. The Chief of Engineers recommended that Federal improvement for tidal flood protection not be undertaken.

"York River Basin Water Quality Management Plan, Volume V-A, Planning Bulletin 229-A, 1976" was prepared by Roy F. Weston for the Virginia State Water Control Board.

"Storm Surge Height-Frequency Analysis and Model Prediction for Chesapeake Bay, Special Report No. 189," dated June 1978 was prepared by the Virginia Institute of Marine Science for the Federal Insurance Administration.

"A Process for the Review and Evaluation of the Management of Virginia's Coastal Resources" was prepared by the Office of the Secretary of Commerce and Resources and adopted in December 1980.

EXISTING CONDITIONS

This section of the appendix provides an overview of the physical, environmental, socio-economic and institutional characteristics of those communities selected for detailed study. A more detailed description of the physical and social characteristics of the communities is found in Appendix C - Recreation and Natural Resources and Appendix D - Social and Cultural Resources.

CAMBRIDGE, MARYLAND

PHYSICAL CHARACTERISTICS

Cambridge is located in Dorchester County in the central part of Maryland's eastern shore where the Choptank River forms the boundary between Dorchester and Talbot Counties. As shown in Figure A-2, Cambridge is located on the Choptank River, one of the two major tidal rivers which drain the county. Dorchester County lies entirely within the Atlantic Coastal Plain and is a low-lying, gently rolling, terraced plain which ranges in elevation from sea level to a maximum of about 50 feet above sea level. The elevations in Cambridge range from sea level to about 30 feet NGVD. The soils of

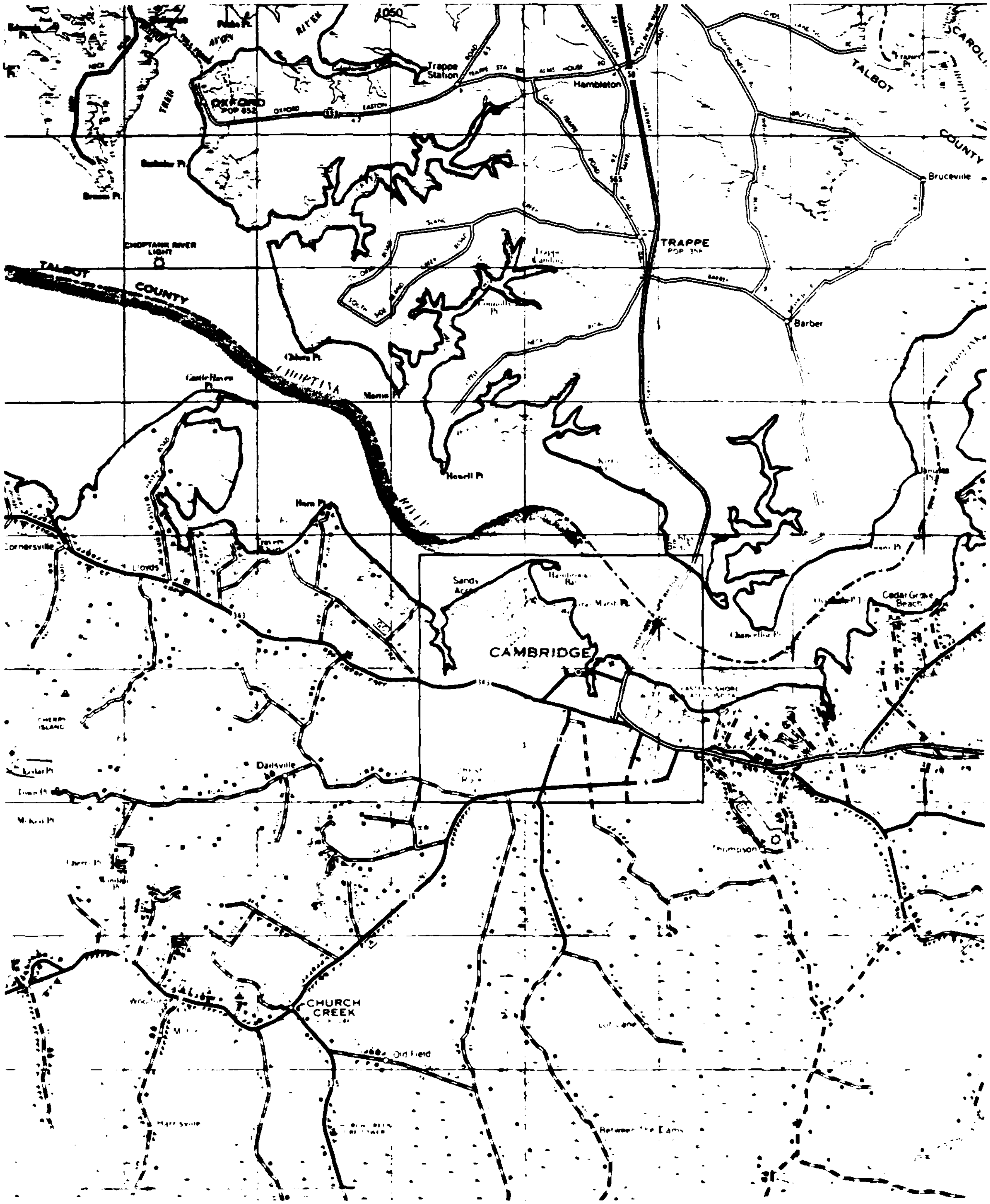


FIGURE A-2 CITY OF CAMBRIDGE AND VICINITY

Dorchester County are loams, sandy loams, silt loams and clay loams. The excellent soil in the county is considered to be one of the most important mineral resources. Sand and gravel are found in the northern part of the county, but are only of sufficient size and quality for local use.

Dorchester County lies in a region midway between the rigorous climate of the north and the mild climate of the south. The county is located in the middle latitudes and has a continental type climate with four well defined seasons. The Chesapeake Bay and the Atlantic Ocean, to a lesser extent, tend to control the climate by moderating the temperature. The mean annual temperature is approximately 56 degrees (F) and the average annual precipitation is approximately 43 inches.

ENVIRONMENTAL CHARACTERISTICS

Water quality in the Cambridge Harbor area of the Choptank River exceeds bacteriological standards of the State of Maryland for Class II waters (shellfish harvesting). The Cambridge Harbor area has been closed to shellfish harvesting since 1963 due to high concentrations of fecal and total coliform bacteria which are the result of poor or improper sewage treatment and storm runoff from upriver sources. Although a large number of industries discharge their effluents into the river, the river does not appear to have a heavy metal problem.

With regard to the biota of the area, the Choptank River downstream from Cambridge supports a viable oyster fishery during the fall and winter, and a blue crab fishery during the summer and fall. The Choptank also supports a variety of finfish which are harvested commercially and for sport. Important species of finfish include blue back herring, alewife, striped bass, white perch, catfish and American shad. The Choptank River is one of the more important waterfowl areas in the Upper Chesapeake and supports large populations of several varieties of ducks and geese. The fish and wildlife benefit from the wetlands of the area which are comprised primarily of coastal salt marsh and irregularly flooded salt marsh.

SOCIO-ECONOMIC CHARACTERISTICS

In 1970, Cambridge had a popluation of 11,595 which represented a 5.2 percent decrease from that reported in 1960. The population was somewhat aged with 48 percent of the population 35 years or older. The occupational distribution of Cambridge was highly concentrated in the operatives category (29 percent). The overwhelming majority of industrial employment in Cambridge was in the manufacturing sector (39.7 percent) followed far behind by the wholesale and retail trade sector (17.1 percent). Unemployment in 1970 was approximately 5 percent.

With regard to transportation, Cambridge is served by a network of state and Federal highways. Rail, bus, truck and air service are available either in the community or within close proximity. The Port of Cambridge is the only deepwater seaport on the eastern shore. The existing Federal navigation channel (16 feet deep) and an existing state navigation channel (25 feet deep) handle primarily fish products and sand, gravel, crushed rock and slag.

Table A-4 shows the various types of land use in the City of Cambridge. Most significant is the agricultural and wooded areas followed by residential development. It should be noted that annexations in 1974 and 1976 increased the area of the City by almost 1500 acres.

TABLE A-4

LAND USE IN CAMBRIDGE, MARYLAND
(1976)

CATEGORY	ACREAGE	PERCENT OF TOTAL
Residential	952.7	27.7
Commercial	219.0	6.4
Industrial	180.7	5.2
Agricultural, Wooded	1,711.5	49.7
Public, semi-public	247.7	7.2
Parks, open space	132.4	3.8
TOTAL	3,444.0	100.0

There are approximately 260 sites in the vicinity of Cambridge identified by the Maryland Historical Trust as being significant to the history of the town and county and which will be submitted for inclusion in the National Register of Historical Places. Four of these sites, Glasgow, Brinsfield I Site, Stanley Institute, and Yarmouth are currently listed on the National Register. In terms of reported archeological sites in the vicinity of Cambridge (within a one mile radius), the Maryland Geological Survey identified five existing sites (two historical, three aboriginal) of low to medium sensitivity (i.e., may be eligible for inclusion in the National Register). The Maryland Geological Survey also noted that there is high potential for significant archeological resources within Cambridge.

INSTITUTIONAL CHARACTERISTICS

Water resources planning in Cambridge may effect or be affected by various water resouces-related programs at the Federal, State and local level. Those Federal and State of Maryland agencies most likely to influence planning are listed in Table A-5.

At the local level, Dorchester County is governed by five commissioners who are elected for a term of four years. Cambridge also has a commissioner type of government. The local agencies most affected by water resources programs would include those responsible for recreation, planning and zoning, transportation, education and county services.

CRISFIELD, MARYLAND

PHYSICAL CHARACTERISTICS

Crisfield, the southernmost city in Maryland, is located in Somerset County at the terminus of Maryland Route 413. The community as shown in Figure A-3 is on the Little Annemessex River, just off Tangier Sound at the lower portion of Maryland's Chesapeake

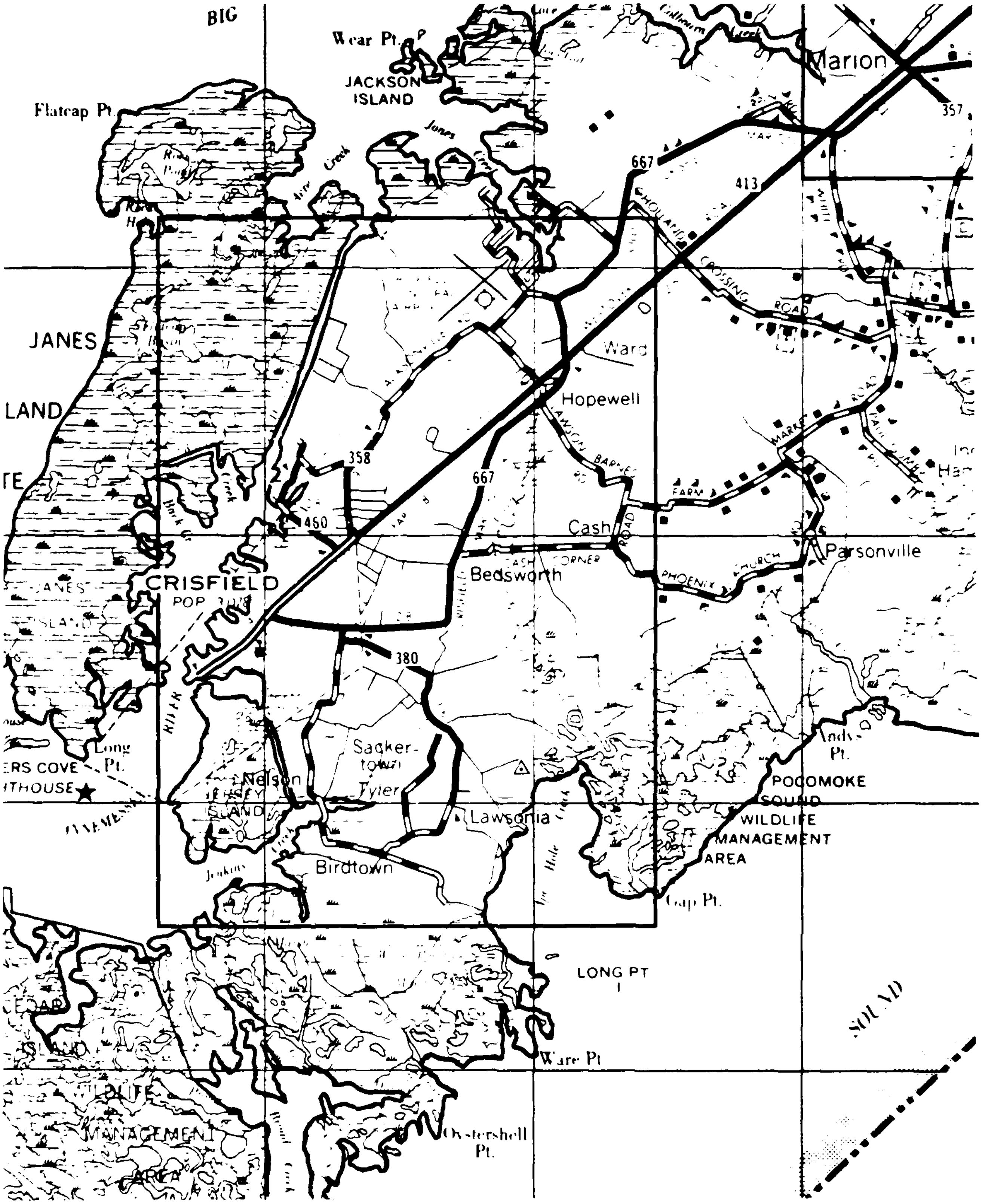


FIGURE A-3 TOWN OF CRISFIELD AND VICINITY

Bay. Somerset County is extremely flat and low with only a small portion of the county having an elevation of 50 feet or more (NGVD). The elevations in Crisfield range from about zero NGVD to about 10 feet NGVD. The soils in the Crisfield area are generally poorly drained and are classified as having only "fair suitability" for agricultural purposes.

TABLE A-5

FEDERAL AND STATE AGENCIES
INVOLVED IN WATER RESOURCES PLANNING

FEDERAL

Environmental Protection Agency	Housing and Urban Development
Federal Emergency Management Agency	National Marine Fisheries Service
Fish and Wildlife Service	Coast Guard
National Park Service	Office of Coastal Zone Management
National Weather Service	Geological Survey
Heritage Conservation & Recreation Service	Soil Conservation Service

STATE OF MARYLAND

Department of Natural Resources	Department of Transportation
Department of State Planning	Department of Health and Mental Hygiene
State Historical Preservation Office	

Somerset County has a continental type climate with four well defined seasons. The Bay and the Atlantic Ocean, to a lesser extent, tend to control the climate by moderating the temperature. Based on the county weather station at Crisfield the mean annual temperature is approximately 56 degrees (F) and the average annual precipitation is approximately 43 inches.

ENVIRONMENTAL CHARACTERISTICS

Water quality in the Crisfield area appears to be good. An intensive survey of the Little Annemessex River and its tributaries was conducted during July 1976. All Maryland standards for Class II and Class I water were met. One biological station was also sampled at Crisfield. The species diversity index was 2.90 (3.0 as a minimum for clean water designation) indicating good water quality.

Crisfield and the surrounding area abounds with fish and wildlife. In addition, within the city limits, there are significant vacant areas, many of which are wooded with pine and deciduous trees. The most significant wildlife habitat is the wetlands which comprise 13 percent of the City with most occurring in the Jersey section of the city. This land supports a variety of wildlife including waterfowl, rodents, deer, fox and other species. Vegetation consists primarily of grasses and typical marsh plants with few areas being wooded. The grassy, water areas are important nursery areas for fingerling fish and shellfish.

SOCIO-ECONOMIC CHARACTERISTICS

The 1970 census showed a population of 3,075 for Crisfield. Approximately 53 percent of the population was 35 years of age or older. Population has been declining for several dacades in both Somerset County and in Crisfield.

Crisfield reflects the tendency of Somerset County toward a relatively low skilled labor force with approximately 22.6 percent of the work force aged 16 years or older employed as operatives and with only 15.6 percent of this work force classified as professional or managerial. Industrial distribution of employment in Crisfield indicates that 29.5 percent of the work force 16 years of age or older are employed in wholesale and retail trade while manufacturing constitutes 23.2 percent. Unemployment in 1970 was approximately 16 percent.

With regard to transportation, Md. Route 413 links Crisfield with other areas of the County and is the major highway in the community. Other streets, such as Somerset Avenue, Jacksonville Road, Main Street/Md. 380, and 4th Street/Woodson School Road carry a rather high volume of traffic. At present there is no public transportation and no rail service in Crisfield. Scheduled trucking service does exist for Somerset County.

The Harbor in Crisfield, while authorized for a depth of 14 feet has only an 8-foot channel because of siltation problems. Traffic in Crisfield Harbor is involved predominantly with shellfish. The Crisfield Airport, a municipally operated facility 3 miles north of Crisfield, has two lighted runways. Services and facilities available include fuel, major maintenance, tie downs and taxi service.

The predominant land use category in Crifield is residential. Other information on Somerset County land use policies is scarce with comments limited to the fact that Princess Anne, Westover, and Crisfield are the major areas in the county for residential, commercial, and industrial development. Most heavy concentrations of commercial activity, vacant lots, multi-family use and a few scattered industrial uses occur in a seven-block strip close to the river.

There are four historical sites in the Crisfield vicinity that have been identified by the Maryland Historical Trust as being significant to the history of the town and county and which will be submitted for inclusion in the National Register of Historic Places. One of these, Make Peace, is currently listed on the National Register. In terms of reported archeological sites in the vicinity of Crisfield, the Maryland Geological Survey indicated that there are no sites recorded in the area, though there does exist a high potential for sites within the Crisfield area.

INSTITUTIONAL CHARACTERISTICS

The Federal and Maryland State agencies most likely to influence water resources planning in Crisfield are listed in Table A-5. Somerset County is governed by a Board of County Commissioners consisting of five members who are elected at large for a term of four years. Crisfield is governed by a mayor and three councilmen who are elected for a term of four years. The local agencies with programs which may influence water resource management in Crisfield are those responsible for recreation, planning and zoning, transportation, education and county services.

POCOMOKE CITY, MARYLAND

PHYSICAL CHARACTERISTICS

As shown in Figure A-4, Pocomoke City is located on the Pocomoke River in the southwest part of Worcester County, about 5 miles from the Virginia state line. Worcester County is in the Atlantic Coastal Plain and is generally flat with some elevations rising to as high as 64 feet NGVD. However, the average elevation is about 35 feet NGVD. The four main physiographic divisions are the mainland, and coastal beach, the marshes, and the freshwater swamps. The major portion of the County drains in a southwesterly direction into the Pocomoke River and its tributaries and then into the Chesapeake Bay. The elevations in Pocomoke City range from about zero NGVD to approximately 30 feet above NGVD.

As noted in earlier descriptions of the climatic conditions of the region, Pocomoke City has a continental type climate. Monthly average temperatures range from a low of 38 degrees (F) in January to a high of nearly 77 degrees (F) in July. The mean annual temperature is approximately 57 degrees (F) and the average annual precipitation is approximately 29 inches.

ENVIRONMENTAL CHARACTERISTICS

Generally speaking, the water quality in the Pocomoke River is good with only some localized problems near the major population centers such as Pocomoke City. The problems in the Pocomoke City area may be characterized as overenrichment, oxygen depletion and bacterial contamination that are the result of both non-point (failing septic systems, urban runoff and boating activities) and point (Pocomoke City Wastewater Treatment Plant and industrial discharges) sources.

The Pocomoke River and adjacent wetland area provide an excellent habitat for numerous waterfowl, wildlife and fish species. Unique to the region are several cypress swamps located along the river.

SOCIO-ECONOMIC CHARACTERISTICS

The 1970 census showed that the population of Pocomoke City increased slightly in the period 1960-1970 from 3,329 to 3,573, or by 7.3 percent. The median age of the population in Pocomoke City was 34.5 years which is significantly above the State median of 27.1 years.

The occupational distribution in Pocomoke City shows a preponderance of employment in the sales and clerical category with approximately 26 percent of the work force aged 16 years or older in this group. Industrial employment figures indicate that approximately 27 percent of the industrial employment in Pocomoke City in 1970 was in the area of wholesale and retail trade. Unemployment in 1970 was fairly low at 4.7 percent in the work force.

Rail service is provided directly to Pocomoke City while truck and bus service is regularly provided to the County. The Port of Cambridge is the nearest deepwater port

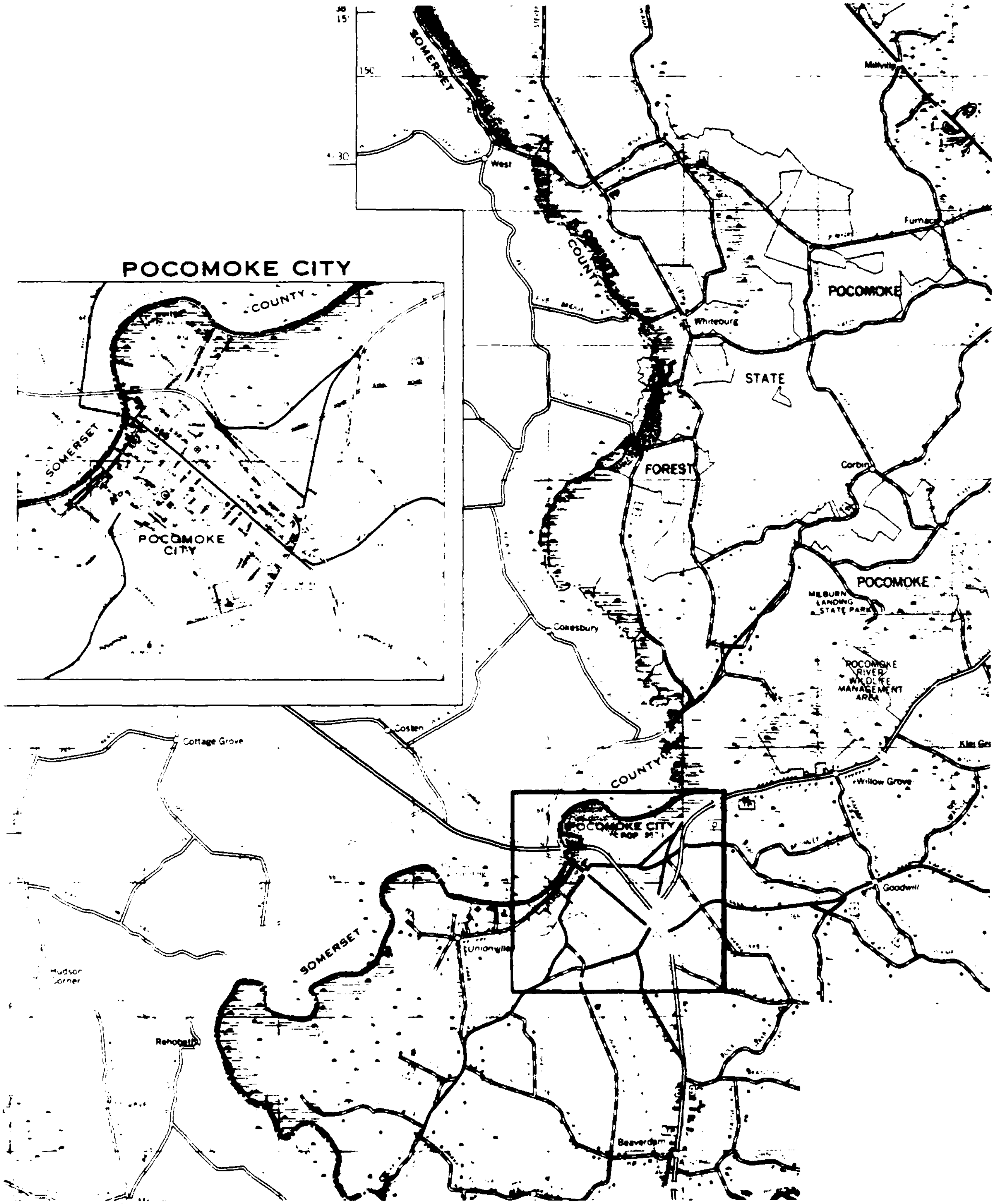


FIGURE A-4 POCOMOKE CITY AND VICINITY

to Worcester County and is located approximately 50 miles northwest of Pocomoke City. The Pocomoke River is commercially navigable and is used for the barging of petroleum products and wood chips. Air service is provided by both the Ocean City Municipal Airport and the Salisbury-Wicomico County Airport.

As seen in Table A-6, the primary land use category in Pocomoke City is residential representing more than one third of the total developed area.

TABLE A-6

LAND USE IN POCOMOKE CITY, MARYLAND
(1966)

LAND USE TYPE	ACRES	PERCENTAGE OF DEVELOPED AREA
Residential	218	36.2
Commercial	27	4.5
Industrial & Utilities	48	8.0
Streets, Highways, Rails	138	23.0
Parks, Cemeteries	124	20.6
Public & Semi-Public	46	7.7

There are nine historical sites in the Pocomoke City vicinity which have been identified by the Maryland Historical Trust as being significant to the history of the town and county. There are no reported archeological sites in the vicinity of Pocomoke City but it should be noted that a systematic survey of the area has not yet been conducted.

INSTITUTIONAL CHARACTERISTICS

Water resources planning in Pocomoke City may affect various water resources-related programs at the Federal, State and local level. Those agencies most likely to be impacted are listed in Table A-5.

Worcester County is governed by five county commissioners who are elected for a four year term. Pocomoke City has an elected mayor and five councilmen who serve two and three year terms, respectively.

ROCK HALL, MARYLAND

PHYSICAL CHARACTERISTICS

Rock Hall, shown in Figure A-5, is located in the southwesternmost portion of Kent County. The County itself is bordered on the north by the Sassafras River, on the east by the State of Delaware, and on the south by the Chester River. The elevations in Rock Hall range from zero to 25 feet above NGVD.

The soils of the county vary. The Elkton type consists of deep, poorly drained soil with a gray, mottled fine textured subsoil. The Othello series consists of poorly drained soils developed on silty deposits underlain by beds of sandy material. The Fallsington series

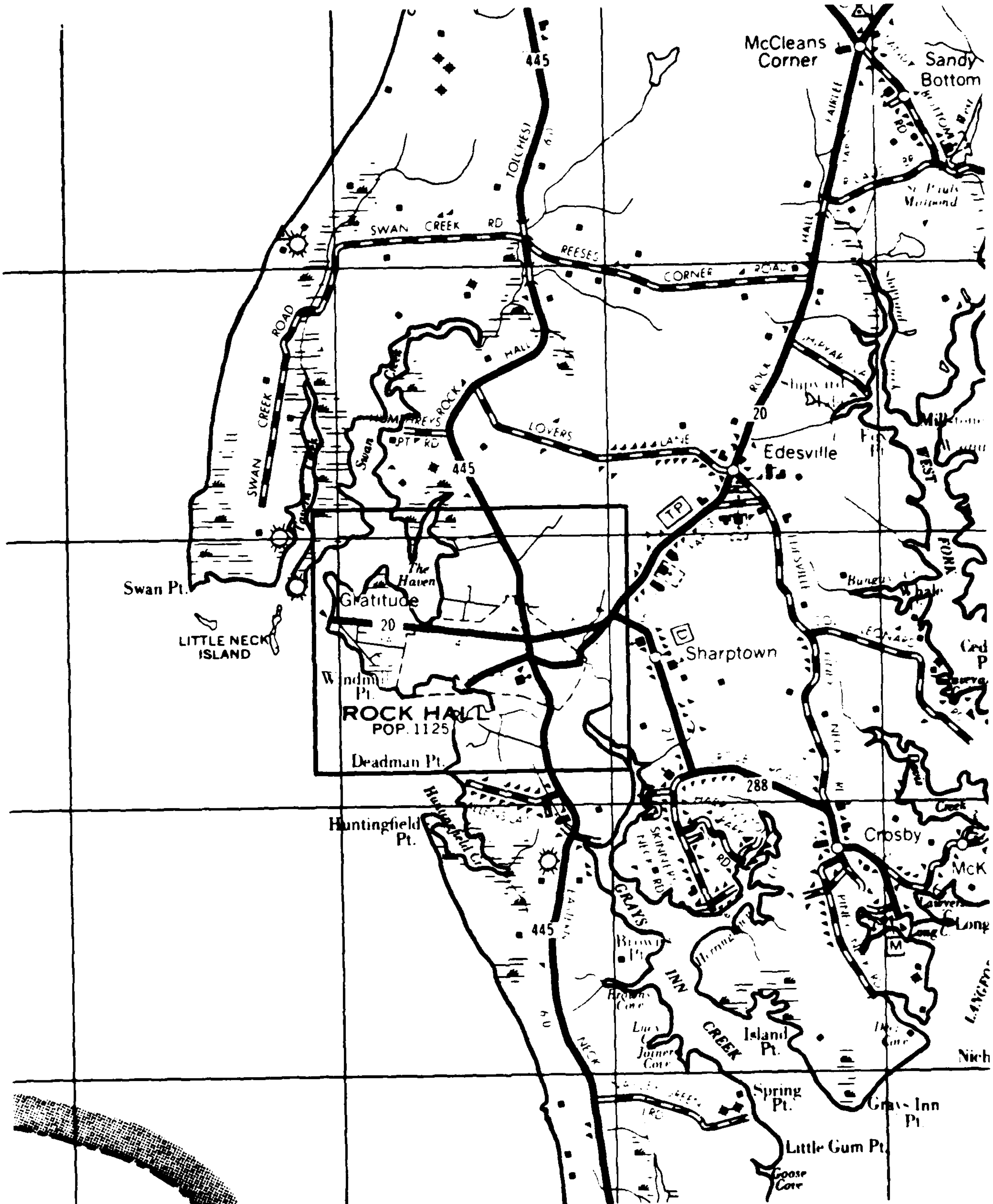


FIGURE A-5 TOWN OF ROCK HALL AND VICINITY

consists of sandy materials containing some silt and clay. All soil types tend to be wet and require tile drainage. The Rock Hall vicinity is characterized by soils of the Elkton-Othello type.

Kent County lies in a region midway between the rigorous climate of the north and the mild climate of the south. The County is located in the middle latitudes and has a continental type climate with four well defined seasons. The Chesapeake Bay and the Atlantic Ocean have a certain modifying effect on the climate of the County. The average summer temperature is approximately 75 degrees (F) and approximately 36 degrees (F) in the winter with average yearly precipitation of approximately 43 inches.

ENVIRONMENTAL CHARACTERISTICS

Water quality in Rock Hall Harbor is not good. Water pollution in this area has closed the offshore shellfish beds since 1964. Sewage disposal in this area of poorly drained soils and limited financial resources is a problem as sewage has been disposed of over the years by means of private subsurface disposal systems or by disposal directly into ditches. A sewage collection and treatment system has been built which provides service to all properties within the city limits. Other sources of pollution are fish processing wastes and the anti-fouling agents used on boat hulls.

The biota of the area is rather restricted with commercial concentrations of clams confined to the area of the Bay south of the Chester River. Though oyster bars do exist in the area of Rock Hall, the Maryland Department of Health and Mental Hygiene notes that the bars have been closed to harvesting since 1964. Rock Hall also serves as a nursery area for finfish with the saltmarshes on the inside of the breakwaters serving this purpose.

The Rock Hall area is heavily used by Atlantic flyway migratory waterfowl. Geese and swans constitute almost 90 percent of the waterfowl in the Chester River while ducks constitute the remainder.

SOCIO-ECONOMIC CHARACTERISTICS

The population of Rock Hall increased 2.6 percent from 1,073 in 1960 to 1,101 in 1970. The median age in 1970 was 34.9 years which compares to the 1970 State figure of 27.1 years.

The occupational distribution of Rock Hall is concentrated in traditionally low-skilled categories such as laborers and clerical and sales. The majority of industrial employment in Rock Hall occurs in the area of wholesale and retail trade, closely followed by the construction and manufacturing categories, with emphasis on marine-related activities in the lattermost category. Though unemployment in 1970 was fairly low at 3.9 percent, the County, since 1972, has been designated as "substantially and persistently" unemployed by the Department of Commerce Economic Development Administration.

Truck, bus, and rail service are available in Chestertown. The closest air service is provided by the Greater Wilmington Airport, located approximately 60 miles northeast of Rock Hall. The nearest deepwater port on the eastern shore is located in Cambridge approximately 50 miles south of Chestertown. The harbor of Rock Hall has an approach channel of 15 feet in depth and handles primarily commodities such as fish products.

Land use in Rock Hall is shown in Table A-7 which indicates that the most significant category is residential.

TABLE A-7

LAND USE IN ROCK HALL, MARYLAND
(1965)

LAND USE TYPE	ACRES	PERCENTAGE OF DEVELOPED AREA
Residential	104.6	52.0
Commercial	8.5	3.5
Industrial	9.6	3.0
Public & Semi-Public	28.4	10.0
Streets and Roads	50.8	31.0

There are 18 sites in the Rock Hall area identified by the Maryland Historical Trust as being significant to the history of the town and county. In terms of reported archeological sites in the vicinity of Rock Hall, the Maryland State Archeologist has indicated that there are six sites reported of medium sensitivity. It has also been noted that there is a high potential for significant archeological resources within Rock Hall due to the community's use as a landing in the early 17th century.

INSTITUTIONAL CHARACTERISTICS

Kent County is governed by three commissioners elected for a term of four years. The local agencies most affected by water resources programs would include those responsible for recreation, planning and zoning, transportation, education and county services.

Water resources planning in Rock Hall may affect or be affected by various water resources-related programs at the Federal, state and local level. Those Federal and Maryland State agencies most likely to influence planning are listed in Table A-5.

SNOW HILL, MARYLAND

PHYSICAL CHARACTERISTICS

As shown in Figure A-6, Snow Hill is located 30 miles upstream from the mouth of the Pocomoke River in central Worcester County, approximately 145 miles south of Philadelphia and approximately 12 miles from the Atlantic Ocean. The elevations in Snow Hill range from zero to 25 feet above NGVD while the County elevations have an average of approximately 35 feet above NGVD.

The county is located in the middle latitudes and has four well defined seasons. The Atlantic Ocean has a considerable modifying control on the County's climate. The average summer temperature of the County is 74.8 degrees (F) and 38.7 (F) degrees in the winter with average yearly precipitation of approximately 29 inches.

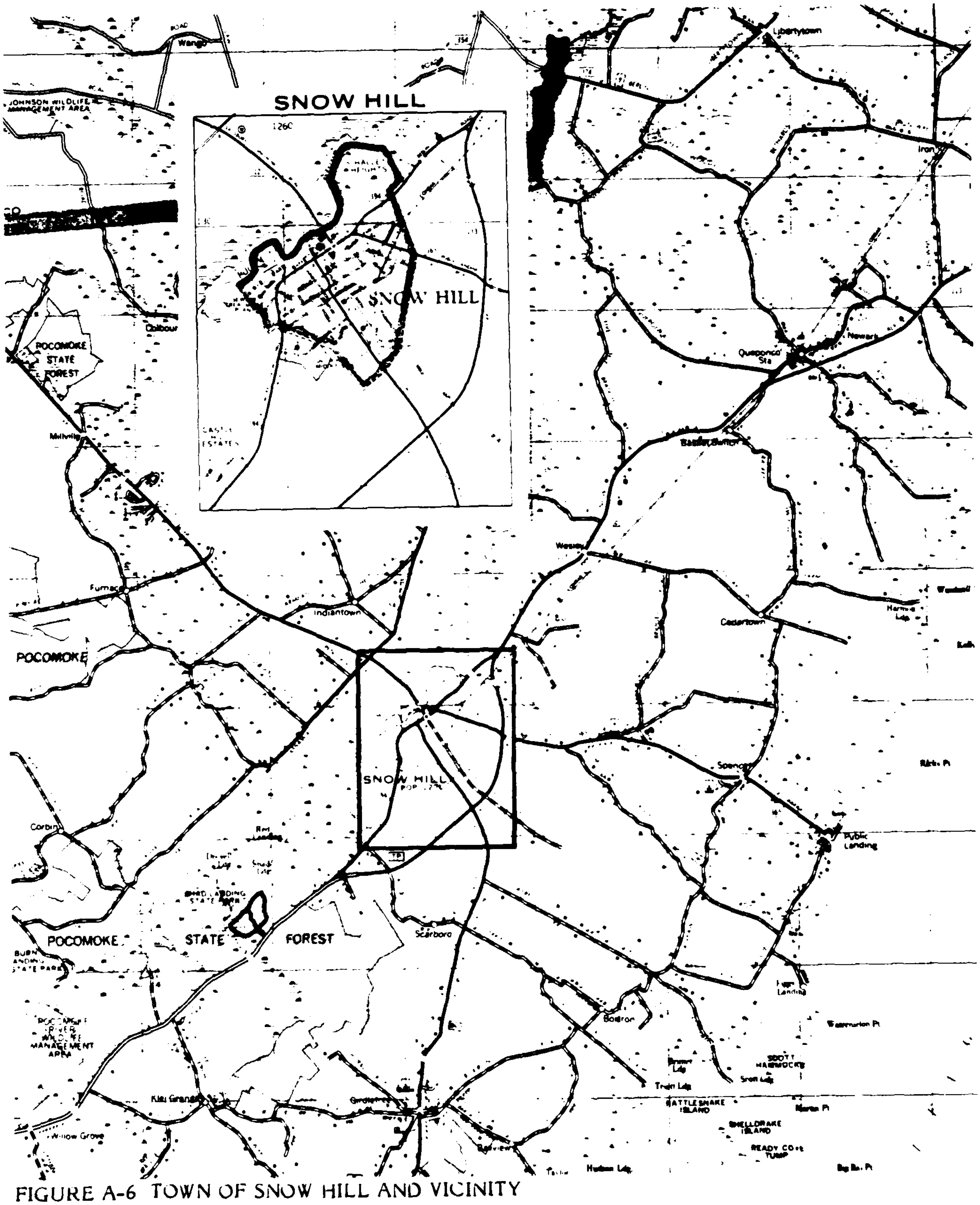


FIGURE A-6 TOWN OF SNOW HILL AND VICINITY

ENVIRONMENTAL CHARACTERISTICS

Water quality in the Snow Hill area of the Pocomoke River seems fairly good, with generally all Class I standards for dissolved oxygen, pH, turbidity and fecal coliform values being met.

Biota in the area includes largemouth bass, black crappie, striped bass, branch herring, hickory shad, white shad, pickerel, and channel catfish. Puddle ducks use the area for resting and feeding while the area is also utilized by wood ducks.

SOCIO-ECONOMIC CHARACTERISTICS

The 1970 census indicated that the population of Snow Hill decreased by 4.8 percent, from 2,311 to 2,201, over the 1960-1970 period. The 1970 census also indicated that the median age of the population was 33.3 years which was significantly higher than the State median age of 27.1 years.

The occupational distribution of Snow Hill indicates that a large portion of those employed in the town are in traditionally low-skilled, low income occupations such as operatives and sales and clerical categories. The industrial employment distribution in Snow Hill reveals a large proportion of the work force (approximately 35 percent) employed in the manufacturing sector which is very consistent with both State and County trends. Moreover, this manufacturing employment seems to be fairly diverse.

Rail service is provided directly to Snow Hill, while truck, air and bus service is provided to the county. There is no public transportation in the town of Snow Hill. The port of Cambridge is the nearest deepwater port to Worcester County and is located approximately 50 miles northwest of Snow Hill. Snow Hill is at the head of navigation on the Pocomoke River which is used primarily for barge transportation of petroleum products and wood chips.

Land use in Snow Hill as shown in Table A-8 indicates that the predominant use in the town is for residential purposes.

TABLE A-8

LAND USE IN SNOW HILL, MARYLAND
(1974)

LAND USE TYPE	ACRES	PERCENTAGE OF URBAN DEV. WITHIN CORPORATE LIMITS
Residential	250	61.0
Commercial	15	3.9
Industrial and Utilities	54	13.9

There are approximately 40 sites in the vicinity of Snow Hill which have been identified by the Maryland Historical Trust as being of significance to the history of the town and county.

In terms of reported archeological sites in the vicinity (approximately a one mile radius of the town) of Snow Hill, the Maryland State Archeologist indicated that there are two reported sites of medium sensitivity. It should be noted that Snow Hill is one of the oldest towns in Maryland and possesses a high potential for significant archeological resources.

INSTITUTIONAL CHARACTERISTICS

Water resources planning in Snow Hill may affect or be affected by various water resources-related programs at the Federal, State, and local level. Those Federal and Maryland State agencies most likely to influence planning are listed in Table A-5.

At the local level, Worcester County is governed by five County commissioners who are elected for a four year term. The local agencies most affected by water resources programs would include those responsible for recreation, planning and zoning, transportation, education and county services.

ST. MICHAELS, MARYLAND

PHYSICAL CHARACTERISTICS

St. Michaels is located in the eastern portion of Talbot County on the Miles River as shown in Figure A-7. The elevations in St. Michaels range from zero to 15 feet above NGVD. The elevation in the County rarely exceeds 20 feet with the land gently sloping higher to the east, northeastern part of the County. The highest point is 72 feet NGVD about three miles east of Easton. Talbot County is part of the Atlantic Coastal Plain and its topography is mostly flat.

The County lies in a region midway between the colder climate of the north and the mild climate of the south. It is located in the middle latitudes with four well defined seasons. The average summer temperature is 75.2 degrees (F) and 36.7 degrees (F) in the winter. Average yearly precipitation is 41.7 inches.

ENVIRONMENTAL CHARACTERISTICS

Water quality in 1977 near the mouth of the Miles River showed an increase of all nitrogen compounds over the 1975 levels, but no change in other compounds. Dissolved oxygen generally decreased from the mouth of the river upstream, but did not fall below the state water quality standards. However, there have been numerous fish kills in St. Michaels Harbor due to failing septic tanks, boat and marina wastes and urban and agricultural runoff. A recently constructed waste water treatment plant is expected to relieve septic system problems.

The most significant wildlife habitats in the County are in the areas adjacent to the more than 600 miles of shoreline. The shallow areas of the River and Bay serve as spawning grounds for many species of fish and provide nourishment for young animal forms.

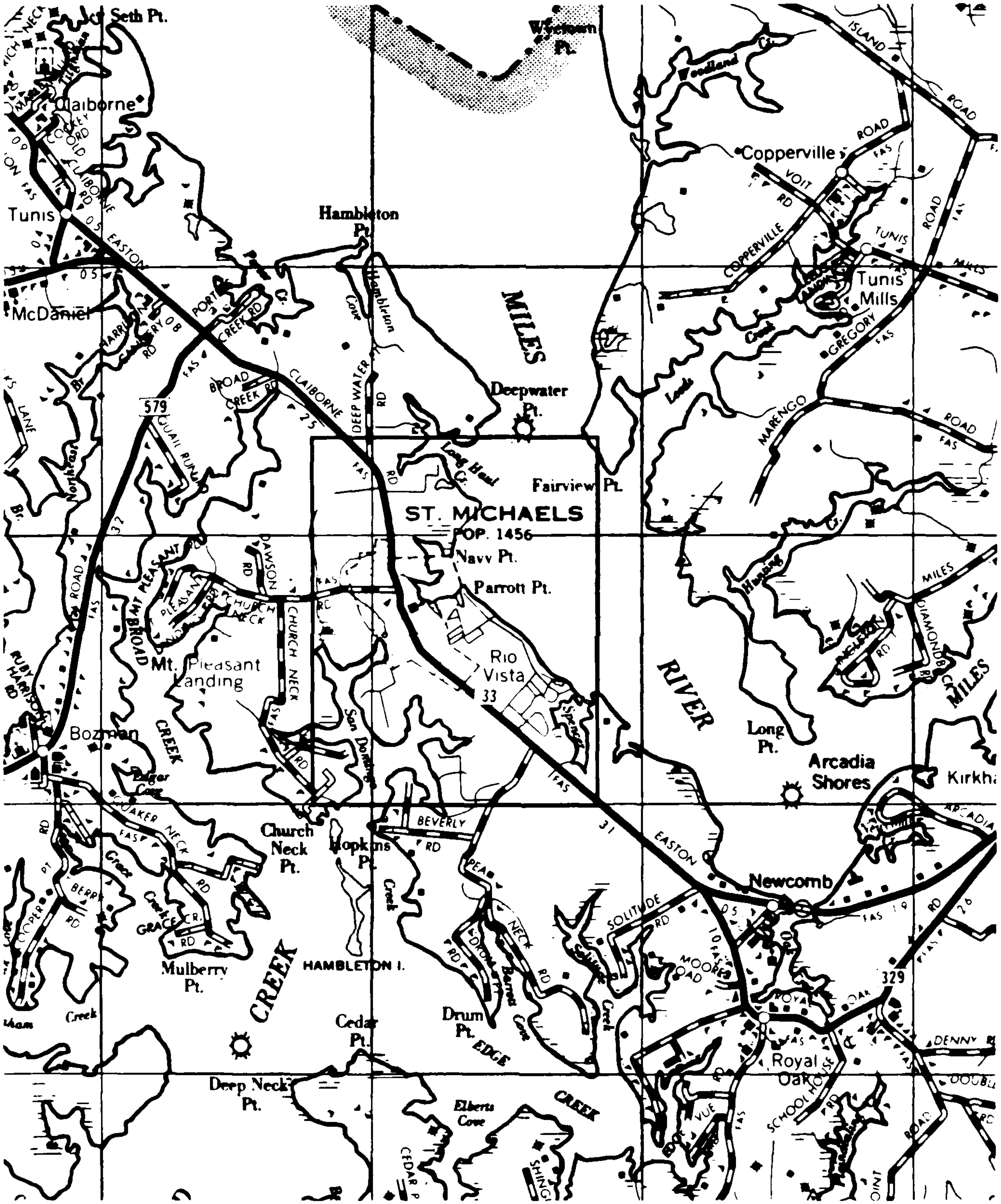


FIGURE A-7 TOWN OF ST. MICHAELS AND VICINITY

Principal finfish species found in the waters around St. Michaels are striped bass, spot, weak fish, white and yellow perch. In the past, St. Michaels was known to have some of the largest blue crabs in the Chesapeake Bay area. Two oyster bars lie just outside the entrance to St. Michaels Harbor.

Waterfowl in the area consist of puddle ducks, Canada geese, and whistling swans. Osprey are also known to utilize the area with mourning doves and woodcock among the migratory game birds in the area.

SOCIO-ECONOMIC CHARACTERISTICS

The 1970 census indicated that the population of St. Michaels decreased by 0.9 percent, from 1,484 to 1,470 over the 1960-1970 period. The median age of the population of St. Michaels in 1970 was 35.8 years which was significantly higher than the State figure of 27.1 years.

The occupational distribution of St. Michaels indicates that the majority of those 16 years of age or older are employed as craftsmen or in the services sector. The majority of industrial employment in St. Michaels is in the manufacturing and wholesale and retail trade categories, with most of the former category concentrated in marine-related activities. Unemployment in St. Michaels in 1970 was very low at only 2.9 percent of the work force.

Rail, truck, bus, and air service is provided to Talbot County but none serve St. Michaels on a regular basis. The nearest deepwater port to St. Michaels is that of Cambridge, which is located approximately 15 miles south of Easton. Commodity movements in St. Michaels Harbor are almost totally concerned with shell and finfish.

Land use in St. Michaels is shown in Table A-9 which indicates that most of the land in the Planning Area is used for residential purposes. It should be noted that most of the recent residential development in the St. Michaels area has occurred southeast of the town in the Rio Vista area.

TABLE A-9

LAND USE IN ST. MICHAELS, MARYLAND

TYPE OF LAND USE	ACRES	PERCENTAGE OF DEVELOPED AREA
Residential	222.4	44.7
Commercial	18.2	3.6
Industrial	9.3	1.9
Public and Semi-Public	46.0	9.1
Streets, Rails, Utilities	186.7	37.2

There are 13 sites in the St. Michaels vicinity which have been identified by the Maryland Historical Trust as being significant to the history of the town and county. The Maryland State Archeologist lists no recorded archeological sites in the St. Michaels area (within a one mile radius of the town) but notes that the potential for sites is rather high.

INSTITUTIONAL CHARACTERISTICS

Water resources planning in St. Michaels may affect or be affected by various water resources-related programs at the Federal, State and local level. Those Federal and Maryland State agencies most likely to influence planning are listed in Table A-5. Talbot County is governed by a five member County Council which is elected for a four year term. St. Michaels has an elected five member board of town commissioners.

TILGHMAN ISLAND, MARYLAND

PHYSICAL CHARACTERISTICS

Tilghman Island, shown in Figure A-8, is located in Talbot County, Maryland, in the central portion of Maryland's eastern shore. The Island is about 3.5 miles long and 1 mile wide and is separated from the mainland by Knapps Narrows. The Island is bordered on the west by Chesapeake Bay and on the east by the mouth of the Choptank River. Elevations on the Island range from about zero NGVD to approximately 10 feet above NGVD. The climatic conditions are the same as those previously described for St. Michaels.

ENVIRONMENTAL CHARACTERISTICS

The waters adjacent to the Island are closed to shellfish harvesting because of poor septic systems on the Island. Water samples indicate that coliform counts exceed the Maryland standards.

Finfish in the vicinity of Tilghman Island include those species typical for Bay waters having a salinity of 9-14 parts per thousand (ppt). The important commercial species include striped bass, spot, weakfish and white perch. The area also serves as an important concentration area for a great variety of waterfowl and supports the greatest local concentration of breeding black ducks in the entire Upper Chesapeake Region. There are several designated wetland areas on or adjacent to Tilghman Island. These areas serve as valuable nursery areas for many species of fish and invertebrates.

SOCIO-ECONOMIC CHARACTERISTICS

The 1970 census indicated that the population of Tilghman Island was 1,180. The median age in 1970 was 34.6 years reflecting a somewhat older population than does the State median of 27.1 years.

The occupational distribution of Tilghman Island is also concentrated among some very low-paying, low-skilled occupations, with approximately 40 percent of the work force aged 16 years or older employed in the operatives category. The work force is sorely lacking professional and technical workers. Industrial employment figures indicate that approximately one quarter of the work force aged 16 years of age or greater are employed in the manufacturing sector which is almost exclusively water-oriented in the case of Tilghman Island.

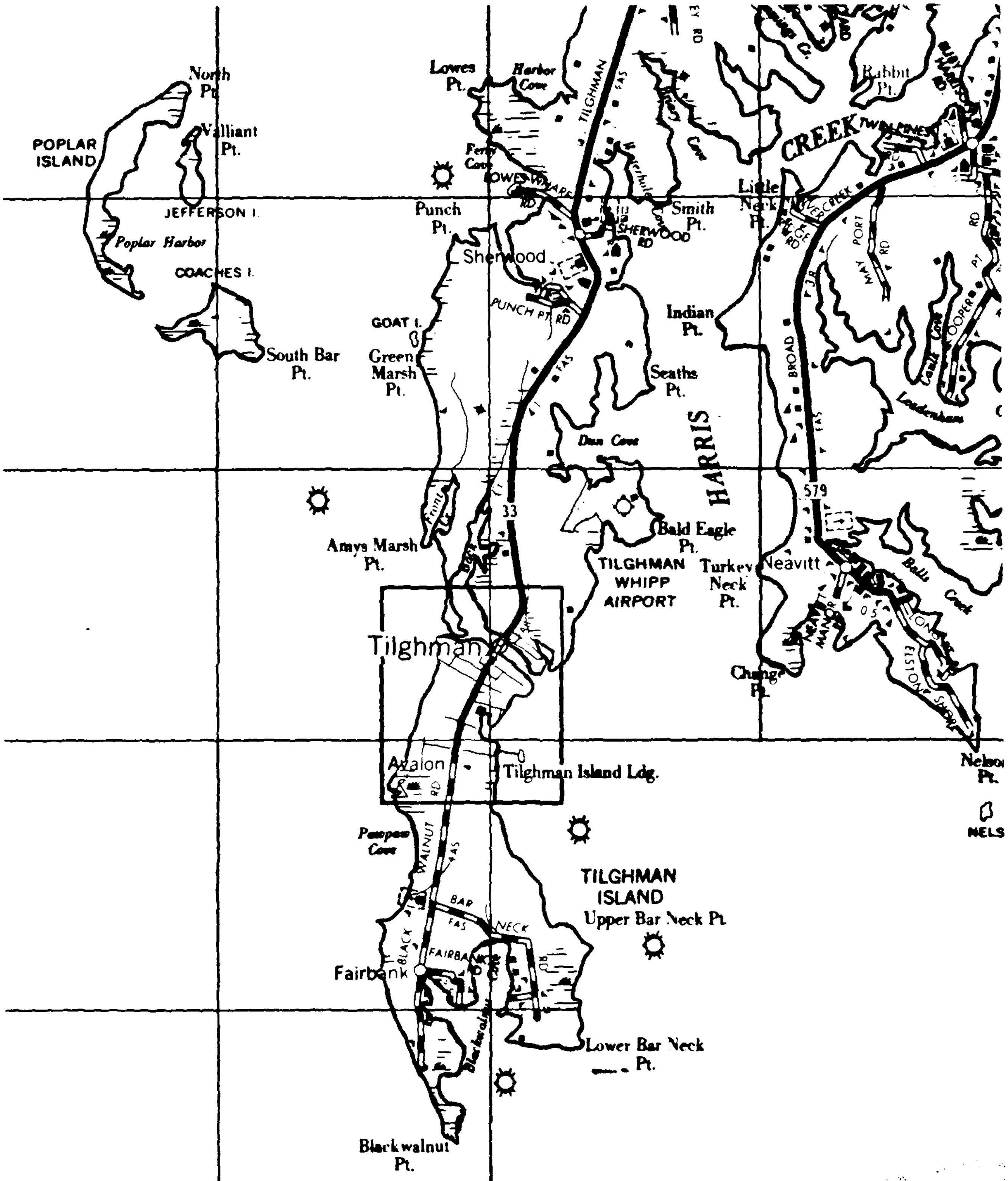


FIGURE A-8 TILGHMAN ISLAND AND VICINITY

Transportation on Tilghman Island is rather limited due to its relative isolation in the westernmost portion of the County. Rail service is available in Easton, some 20-25 miles to the east. Trucking sevice is available on an "as required" basis, while bus service is provided to the County. Cambridge is the nearest deepwater port to Tilghman Island while air service is provided by the Easton Municipal Airport. Waterborne commerce in Knapps Narrows is involved almost exclusively with fish products.

Land use information for Tilghman Island is not available. Field survey notes indicated that the major use of land is for residential purposes with only scattered commercial uses along Route 33 and in the Knapps Narrows area.

There are two historic sites in the Tilghman Island vicinity that have been identified by the Maryland Historical Trust as of historical significance to the history of the town and County. There are no known archeological sites in the vicinity of Tilghman Island though there is a high potential for significant archeological resources in the area.

INSTITUTIONAL CHARACTERISTICS

Water resources planning in Tilghman Island may affect or be affected by various water resources-related programs at the Federal, state, and local level. Those Federal and Maryland State agencies most likely to influence planning are listed in Table A-5. Talbot County is governed by a five member County Council which is elected for a four year term.

CAPE CHARLES, VIRGINIA

PHYSICAL CHARACTERISTICS

Cape Charles is an incorporated town located on the western shore of the Delmarva Peninsula approximately 11 miles from the entrance of Chesapeake Bay. It lies in the southwestern portion of Northampton County, as shown in Figures A-9 and A-10. Figure A-11 is an aerial photograph of the area. Northampton County contains approximately 140,000 acres of land and water, 95 percent of which is undeveloped beach, marsh, forest, or farmland. The topography of the area is relatively flat, with elevations ranging from about zero NGVD to 12 feet NGVD.

The Town of Cape Charles is the largest within the county in terms of both land area and population. It accounted for 31.8 percent of all land and about 37 percent of all population within Northampton's incorportated towns in 1970.

Practically all of Cape Charles existing development has taken place on the low ground near the water's edge. To the south is Cape Charles Harbor, important for commercial fishing vessels and other commerce, while to the north is Kings Creek, a predominantly recreational waterway which is the home port for many charter fishing vessels.

The area has a temperate climate, with a 30-year average year-round temperature of 57.8 degrees F (14.3 C). The rainfall has averaged 42 inches per year during the period from 1931 through 1970, with the heaviest rainfall occurring between June and September.

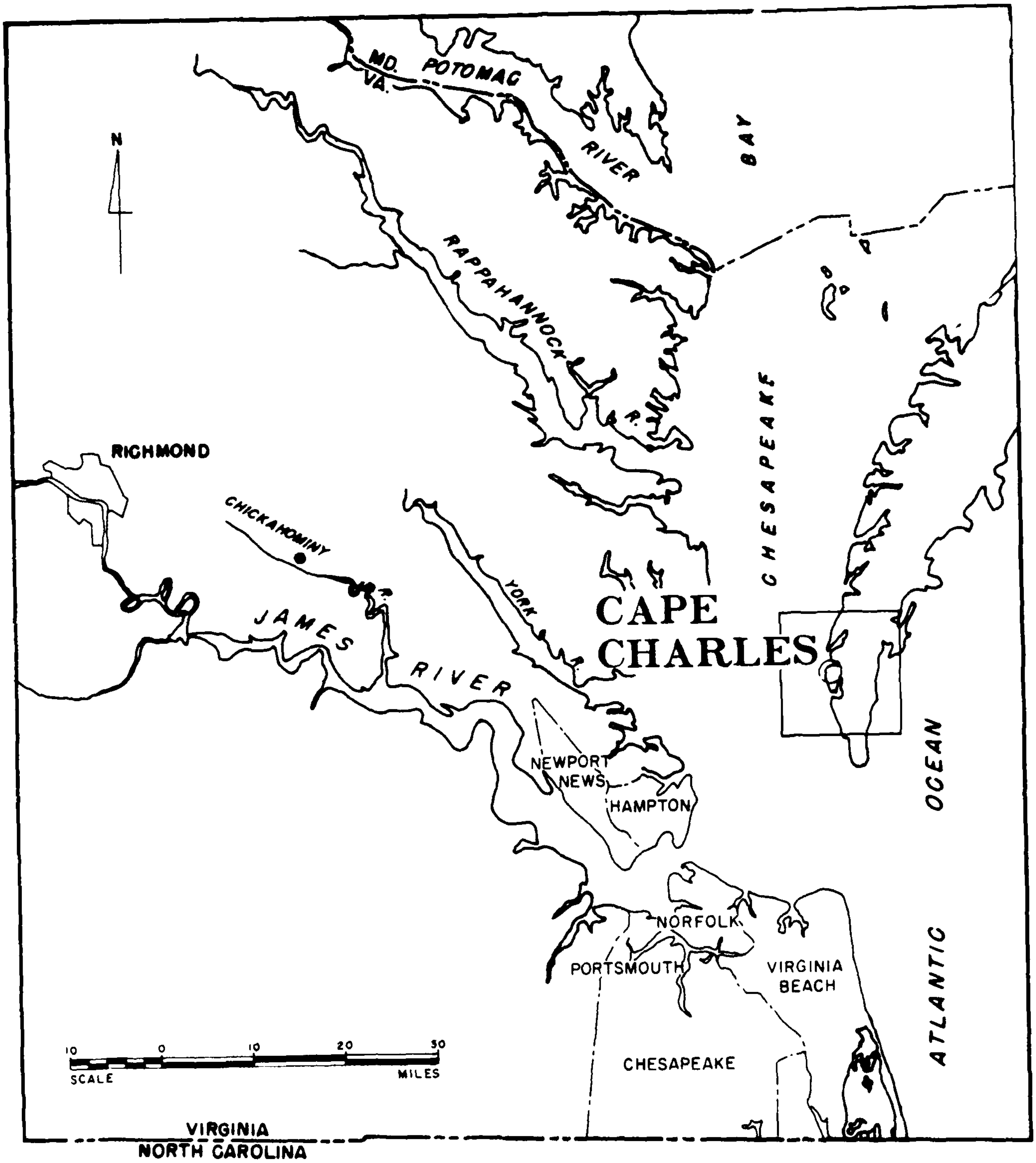
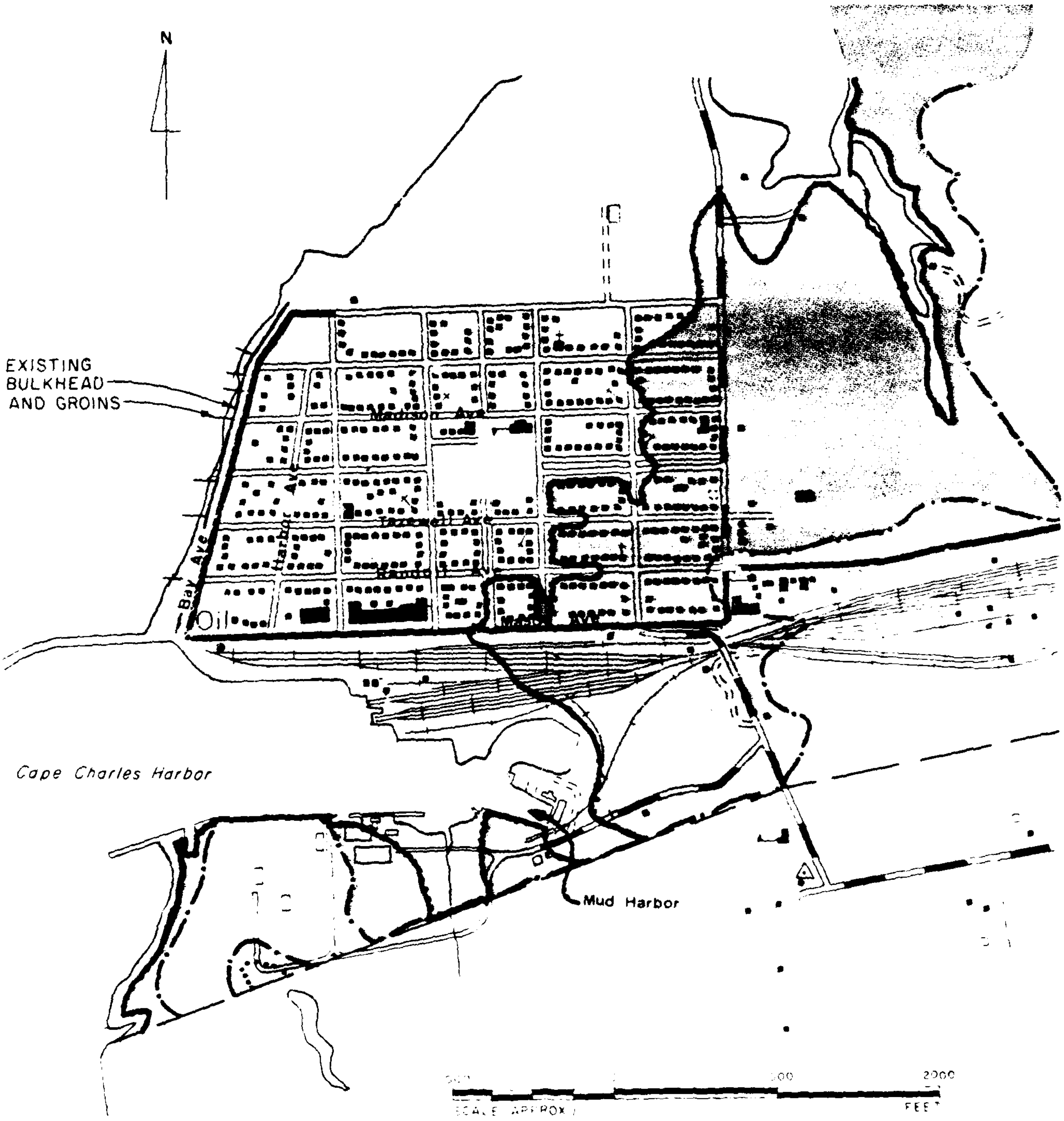


FIGURE A-9 CAPE CHARLES AND VICINITY



LEGEND

INTERMEDIATE REGIONAL TIDAL FLOOD (100 YEAR)

STANDARD PROJECT TIDAL FLOOD

FIGURE A-10 CAPE CHARLES AREA FLOOD MAP

In some years, the Eastern Shore does not receive any snow and rarely does the snowfall exceed eight inches. Severe weather occurs occasionally in the form of tropical storms during the months of July through September. Some of these storms have deposited rainfall in excess of 15 inches, and wind velocities have been known to exceed 125 miles per hour. Tornadoes are rare.

Because of the low elevations, freshwater streams such as Kings Creek are typically narrow and small and only a few miles in length from the headwaters to their discharges into the tidal estuaries. Therefore, freshwater flow is minimal. Typically in such streams, the 7-day, 10-year low flow is zero.

Water for the town is supplied by a municipally owned system consisting of two well fields. A local sewage sytem services 670 residential and 70 commercial subscribers and includes a facility for providing secondary treatment. This plant has recently been unable to operate however, because of surcharges in the network of collector lines during storms and abnormally high tides. Meanwhile 0.125 MGD of raw sewage is discharged into Cape Charles Harbor. Electric power to the town is supplied by the Delmarva Power and Light Company of Virginia. The 1,200 kilowatt internal combustion plant is self-contained and no cooling water is required.

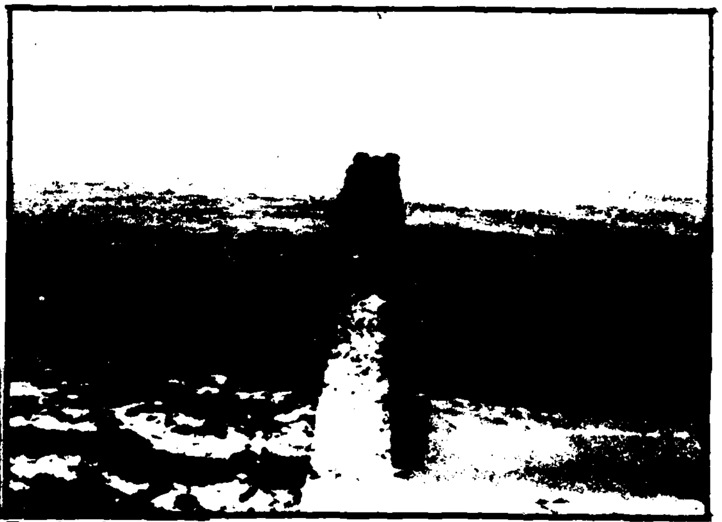
Cape Charles connects with the "Ocean Highway," U.S. Route 13, by a first class, three-lane concrete road 2.4 miles long. Immediately to the south, U.S. Route 13 connects with the cities of Hampton Roads via a major bridge-tunnel across Chesapeake Bay.

There is a wooden, treated bulkhead that extends 2,400 feet along the Cape Charles shoreline. This bulkhead was designed to protect from high water an adjacent waterfront walkway, the four-lane state highway, and residences that front the highway on the land side. Nine 80-foot long wooden groins are situated along the wall. In addition six large concrete pipe storm sewers from the town outfall on the beach area. Photographs of the bulkhead are shown in Figure A-12.

ENVIRONMENTAL CHARACTERISTICS

In the vicinity of Cape Charles are several major salt marsh habitats. These include the marshes associated with Kings Creek and Cherrystone Inlet directly north of Cape Charles and Old Plantation Creek located to the south. The waters in these adjacent inlets and nearshore are highly productive, containing a variety of living natural resources of commercial and recreational importance. The surrounding land includes agricultural fields, natural woodlands, a golf course, and a limited amount of residential, municipal, and industrial development beyond the immediate vicinity of Cape Charles.

Cape Charles Harbor has bulkheaded shorelines, with numerous docking and pier facilities for a variety of commercial and recreational boats. Public ramps and large parking facilities are also present. Directly south of the harbor entrance the upper shore has been cleared, with buildings and a variety of debris, concrete slabs, etc., scattered along the shoreline. Evidence of dredged material is also found along this shore. An embankment with elevations up to 6 feet is present, but it gradually decreases in elevation southward, with shoreline erosion common. Approximately midway between


Typical jetty


Bay Ave.- Chesapeake Bay and bulkhead at left


Bulkhead and jetties


Bulkhead and jetties

FIGURE A-12 PHOTOGRAPHS OF CAPE CHARLES BULKHEADS

the Cape Charles Harbor entrance and Old Plantation Creek the tree line comes to the edge of the embankment, and at low tide evidence of previous tree development (e.g., roots) is visible on the exposed sandy beach. Progressing into the Bay from this shoreline there exists a series of sand bars, parallel to the beach, separated by shallow depressions. Within this offshore area, mainly at low tide depth from 3 to 9 feet, are scattered sea grass beds. The most abundant form in this area is widgeon grass (Ruppia maritima), with eel grass (Zostera marina) common, but found scattered in lower concentrations. These species are commonly found in both sandy and sand mud bottoms along the shoreline. Marshall (1979) estimated that there were approximately 69.9 acres of sea grass beds in this area in 1977. Most of these beds contain a variety of other fauna, including many common invertebrates and young fish from the area.

The entrance to Old Plantation Creek is bordered by tidal flats along both sides of the main channel. Salt marsh "islands," composed mainly of Spartina alterniflora, are found within the entrance, with an extensive development of this salt marsh cordgrass along the shoreline and within the numerous tributaries of Old Plantation Creek. The estimated acreage of wetlands in Old Plantation Creek and its tributaries has been given by Moore (1977) as 133.8 acres, with 123 acres composed of Spartina alterniflora. Located 0.9 miles south of Old Plantation is Elliotts Creek, which contains the last significant marsh south along this shore until Fisherman's Island. This creek contains an estimated 85.5 acres of salt marsh.

North of Cape Charles Harbor, a bulkhead (elevation 8.0 feet) extends for 2,400 feet to offer protection from wave action and moderate-size floods. Offshore several large eel grass beds have been reported and these extend into Kings Creek, Cherrystone Inlet, and offshore waters directly north of Wescoat Point. Marshall (1979) has estimated approximately 360 acres of sea grass were in this area duirng 1977-78. Kings Creek has 28.9 acres of salt marsh stands along its shoreline, of which 23.3 acres are stands of Spartina alterniflora. An additional 36 acres of salt marsh are located along the shoreline north to Cherrystone Inlet, with 298.9 acres in Cherrystone Inlet (Moore, 1977). These creeks and inlets represent suitable nursery grounds for various fish, such as spot (Leiostomus xanthurus), and menhaden (Brevoortia tyrannus), among others. In addition, these waters represent an important crab pot fishery.

The shoreland area surrounding Cape Charles Harbor is mainly preserved by various bulkheads, several boat ramps, and pier facilities. Mooring accommodations are for both commercial and recreational boats. The shoreland is predominantly used for commercial and industrial purposes. The water quality in the harbor meets water class II-B standards, but not shellfish standards (Athearn, et al., 1974). North of Cape Charles Harbor, the shoreline erosion is slight, with a bulkhead along the shore. This seawall also has nine groins to aid in shore protection.

Water quality here is considered satisfactory, but does not meet shellfish standards. Beyond this area there are no shore protective structures, with erosion slight to moderate. Kings Creek contains an oyster boat landing, two marinas, a boat ramp, and several private wharves. The water quality was satisfactory in spring 1973, but unsatisfactory during the winter months near the marinas (Athearn, et al., 1974). The water quality meets both water class II-B and shellfish standards in Cherrystone Inlet. South of Cape Charles Harbor, the shore consists mainly of past dredged material that is fairly stable for a mile along the shore. South, however, to old Plantation Creek, the shore is subject to erosion at a rate of approximately 3 feet per year (Athearn, et al., 1977).

SOCIO-ECONOMIC CHARACTERISTICS

Cape Charles was one of the first eight Virginia Shores established in 1634. The city was incorporated in 1886 when it represented the terminal point for the Pennsylvania Railroad. It was here that railroad and passenger cars were loaded on a ferry and transported out of the area. The ferry was discontinued in 1951, and since that time the population of Cape Charles has decreased to 1,512 (1980 Census). The town accounts for 10.3 percent of Northampton County's population of 14,625. It is one of only five incorporated towns, whose population is less than one-half of the county's. Cape Charles' economy is based on farming, fishing, some tourism, and light industry. In land area, the town is less than one square mile as compared with 220.1 square miles for the county.

Located at Cape Charles Harbor is one of the largest private employers in Northampton County, Bayshore Concrete Products Corporation. Employing between 100 and 299 persons in 1981, it produces concrete poles and bridge and pier components.

The Cape Charles oyster area was among the top 50 U.S. ports for poundage and value of seaford in 1980. Shellfish was the largest portion of seafood landed. According to National Marine Fisheries statistics, over 50 percent of Virginia's total surf clam landings were from Northampton County. Actual tons of commodities moving through the port are shown in Table A-10.

TABLE A-10

MAJOR COMMODITY GROUPS OF
WATERBORNE COMMERCE FOR CAPE CHARLES
(tons)

COMMODITY GROUP	1974	1976	1978	1981
Fresh fish, except shellfish	113	177	15	N/A
Shellfish, except prepared	8,634	16,024	8,296	3,529
Sand, gravel and crushed rock	112,734	71,191	65,159	119,755
Fabricated metal products	18,330	9,900	N/A	N/A
Misc. non-metallic mineral products	1,715	N/A	N/A	5,661
Percent of total Cape Charles commerce represented by above commodity groups	100	100	N/A	82

SOURCE: U.S. Army Corps of Engineers, Waterborne Commerce of the U.S.

The greatest amount of manufacturing or industrial employment in the county is in fish and shellfish processing. Using OBERS estimates of 1978 total employment, 40 percent was attributable to agricultural production and services, forestry, fisheries, and food processing. These are primarily basic economic activities generating additional employment in the supporting sector. According to the 1980 County Business Patterns-Virginia (Bureau of the Census), 1,332 persons were employed in manufacturing with 63 percent of these in food and kindred products. Total manufacturing payroll for the year was $10.3 million, with 63 percent again going to the food and kindred products sector.

Retail trade and services, a portion of which is from tourism, were the two other large employers with 596 and 937 employees, respectively. These two sectors, together with manufacturing, accounted for over 75 percent of the county's total 1980 payroll of $28.7 million (excluding earnings of government and railroad employees and self-employed persons).

As recently as May 31, 1983, Northampton County was designated a Labor Surplus Area by the U.S. Department of Labor, indicating a high level of structural unemployment over the preceding two years. For this period, unemployment was 20 percent above the national average rate or 9.0 percent versus 7.5 percent. Unemployment usually reaches its highest point during the year in January and February, reflecting the area's dependence on farming and fisheries.

INSTITUTIONAL CHARACTERISTICS

Northampton County has a county administrator form of government and is divided into three magisterial districts: Franktown, Eastville, and Capeville (which includes Cape Charles). Members of the county's Board of Supervisors are chosen from these districts. The Town of Cape Charles is governed by a mayor and a 6-member town council. The area is also served by the Accomack-Northampton Planning District Commission No. 22, consisting of 12 members, 5 of whom are from Northampton County (the three members of the Board of Supervisors plus two members appointed by the board). There is also an Eastern Shore Soil and Water Conservation District, governed by a six member board of directors.

HAMPTON ROADS, VIRGINIA

PHYSICAL CHARACTERISTICS

The following report is confined primarily to that portion of the Hampton Roads area encompassing the cities of Norfolk, Portsmouth, Chesapeake, and Hampton as shown in Figure A-13. They are located 180 miles southeast of Washington, D.C. The land areas include about 50 square miles in Norfolk, 30 square miles in Portsmouth and 55 square miles in Hampton. Chesapeake contains 350 square miles but only a small portion of this area is affected by storm surges in Chesapeake Bay. The same is true for Virginia Beach. The terrain is low lying and flat with a maximum elevation of 20 feet, except for isolated sand dunes along beach areas.

Most of the area is fully developed or growing rapidly. The cities are largely residential, interspersed with commercial developments and industrial plants. Industrial activities include the manufacture of fertilizer, metal, lumber, and paper products, and shipbuilding and repair. Most of the waterfront is occupied by docks and piers which will

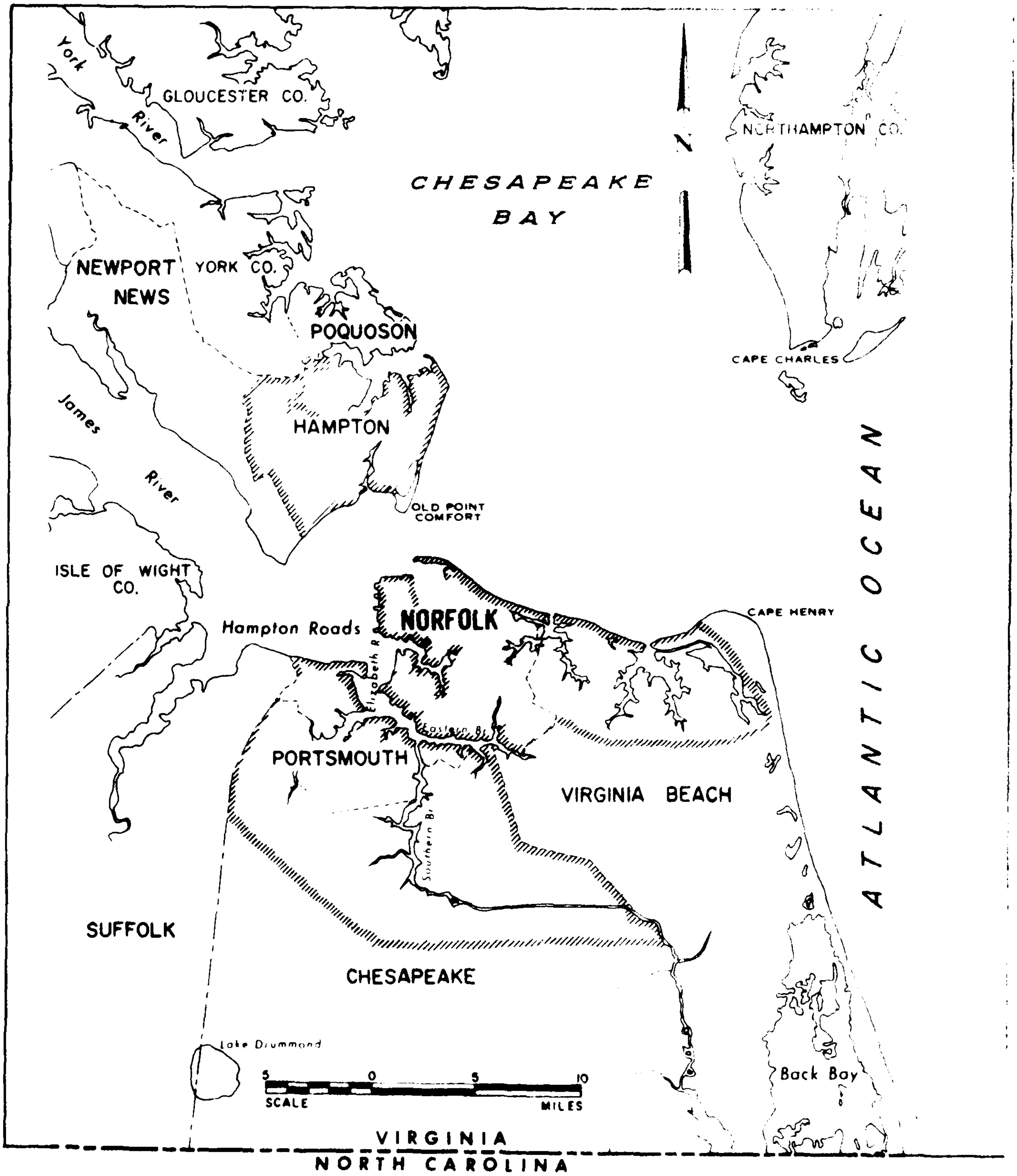


FIGURE A-13 HAMPTON ROADS CITY COMPLEX AND VICINITY

accommodate vessels with a draft of up to 45 feet. The naval facilities in this metropolitan complex are the largest in the world and the economic well-being of the area is highly dependent upon this military establishment.

Interstate 64 and other highways and tunnels cross the waterways in the area. The Norfolk airport serves the cities of Norfolk, Portsmouth, Chesapeake and Virginia Beach. The Newport News airport serves Hampton. Norfolk has its own water supply system, which also supplies Virginia Beach, consisting of both wells and surface storage. Portsmouth has a similar system. Chesapeake was supplied by Norfolk and Portsmouth until November 1980. In November 1980 Chesapeake discontinued the purchase of water from Norfolk. Chesapeake now has a small system that became operational in the spring of 1980. Also Chesapeake has drilled a well but it has not been put into service (Hampton Roads, Virginia Water Supply Feasibility Report (interim) Stage II Documentation, November 1982, Volume II). Hampton is supplied by water from the Newport News system. The Hampton Roads Sanitation District serves the entire area. Electricity to the entire area is provided by the Virginia Electric and Power Company.

The diurnal range of tide varies from about 2.5 feet at the U.S. Naval Base near the mouth of the Elizabeth River, to 2.8 feet at the junction of the Southern and Eastern Branches. Prolonged south winds have depressed the water in the harbor as much as 4 feet below NGVD. On the other hand, storms accompanied by strong northeasterly winds have raised the water to a height of 8 feet above NGVD within the period of record.

ENVIRONMENTAL CHARACTERISTICS

The Hampton Roads region of Virginia represents a multiple city complex in southeastern Virginia centered about Hampton Roads Harbor. Hampton Roads is the natural channel and harbor formed where the James, Elizabeth, and Nansemond Rivers meet. These rivers flow through Hampton Roads into Chesapeake Bay. This harbor is surrounded by the largest urban population concentration in Virginia. As one of the finest harbor complexes in the United States, the area contains two major railroad terminals, shipbuilding and drydock installations, military bases, industrial companies, several deep water terminals for shipping and unloading cargo, and various other supportive enterprises for a major harbor. Terminals are serviced by an extensive railroad and trucking system for inland transport. The export cargo consists of a variety of products including coal, grains, fertilizer, chemicals, fruits, and petroleum products, among others.

The waters of Hampton Roads Harbor are derived from a variety of sources. Precipitation, followed by surface and/or subsurface drainage enters the harbor either directly or through a variety of tidal creeks and small rivers that are distributed along the shoreline. Additional flow to the area comes from the James River and its tributaries, with tidal entry from the lower Chesapeake Bay. Located 18 miles from Hampton Roads Harbor is the mouth of the Chesapeake Bay. The local area is estuarine, subject to tidal influence, river flow, and the various products that enter the system from terrestrial or other sources. The three major river systems entering this area are the James, Nansemond, and Elizabeth Rivers, which are all in the James River Basin. There are also other smaller tidal rivers, such as the Lafayette River in Norfolk and the Hampton River in Hampton, and numerous creeks that enter Hampton Roads Harbor.

The Elizabeth River drains Norfolk, Portsmouth, and portions of Chesapeake, with the Nansemond River primarily draining the wetlands of Suffolk. The James River has its head waters in central Virginia 450 miles from the Chesapeake Bay, with a drainage basin that covers 10,102 square miles, or about 25 percent of the State's surface area (Water Quality Inventory 305(b) Report, 1982).

There are distinct water quality problems in the Hampton Roads area generally stemming from the local river waters. The major water quality problems for the Elizabeth River have been identified in the Water Quality Inventory 305(b) Report (1982) as high nutrient levels, bacteriological contamination, periodic oil spills, high heavy metal and chlorinated hydrocarbon concentrations in the sediment, and occasional sewage overflows. Another problem in this area is the frequent need for dredging and the related stress conditions this invokes to the waters. In addition, there is heavy ship traffic through this area which includes cargo vessels, Naval ships, and pleasure craft that pass through these waters which are part of the Intercoastal Waterway System. The 305(b) Report states that removal of all municipal point source discharges would have an insignificant effect on water quality.

In close proximity to the Elizabeth River, draining a portion of Norfolk, is the Lafayette River. The 305(b) Report describes the water quality in this river as rather poor, especially with respect to fecal coliforms. This condition is attributable to small freshwater inflow, urban runoff, boating and marina activities as well as the influx of wastewater from sewage treatment facilities. Tidal flushing at the mouth of the river is relatively poor allowing nutrients to become concentrated in the waters and sediment in this reach of the river. The Nansemond River also has water quality problems cited by the 305(b) Report. These include high fecal coliform and low dissolved oxygen concentrations from known point discharges and nonpoint sources.

The water quality along the southern shoreline of Hampton was considered unsatisfactory by the Bureau of Shellfish Sanitation as of July 1975. A similar unsatisfactory rating was given for Hampton River, and waters adjacent to Strawberry Banks (Hobbs, et al., 1975).

The lower portion of the James Estuary, including the Elizabeth River system, receives over 100 MGD of treated domestic waste water. In addition to the numerous municipal dischargers, this segment is heavily used by industrial dischargers. All have appropriate permits and most have no major problems with permit compliance. The most significant effects on water quality in this segment may result from nonpoint source pollution. Studies indicate the effect of urbanization and the resulting stormwater runoff, if allowed to proceed unabated, will continue to adversely impact water quality. This will occur regardless of the imposition of more stringent requirements on point source dischargers.

The shorelands of Chesapeake, Norfolk, and Portsmouth have elevations less than 20 feet, of which 75 percent is classified as low shore (20 feet or less of relief) and 25 percent being artificial fill (Owen, et al., 1976). The artificial fill is associated with the various large docking facilities and the Craney Island Disposal Area which is located at the entrance of the Elizabeth River. Owen, et al. (1976) characterized the shoreline as being 38 percent artificially stabilized, but included in his figures a stabilized portion of

the Norfolk beach area outside the harbor entrance along the lower Chesapeake Bay. However, a high percentage of stabilized and/or bulkheaded shoreline frontage is found within Hampton Roads Harbor, especially in the industrialized and downtown areas of Norfolk and Portsmouth.

Industrialization, docking facilities, and related activities are most prevalent along the main channel of the Elizabeth River and its branches (southern, eastern, and western) where there is access to deepwater docking facilities. Beyond these points developed marsh areas become more prevalent. Fringe marshes are common in areas of both residential and industrial usage. Marsh lands become more extensive, in the shallower areas of the river systems. These areas will also have a considerable increase in the amount of residential usage. Owen, et al. (1976) estimated over 50 percent of the shorelands of the Elizabeth River system are used for residential purposes, with 22.1 miles of unmanaged shorelands, most of which is located at the head of the Southern Branch.

Along the north shore of Hampton Roads is the City of Hampton with a land area of 55 square miles and an inland water area of 17.3 square miles. Hampton is bordered along its western side by the City of Newport News and to the east by the Chesapeake Bay. Several small creeks and the Hampton River enter Hampton Roads from the Hampton shoreline. Thirty-five percent of Hampton's entire shoreline possesses bulkheads or seawalls. Combinations of shore protective structures including riprap, groins, and bulkheaded property are common along the shoreline. The Back River and Hampton River systems also contain natural stands of well-developed salt marshes, with fringe marshes common along property bordering Hampton Roads. Areas of severe erosion are found along the eastern shoreline between Back River and Buckroe Beach. The erosion rates between Grandview and Buckroe (6 feet per year) are considered severe and critical by Hobbs, et al. (1975). This area has mainly a sand beach, containing groins, several seawalls, and some pier facilities. The shoreline bordering Hampton Roads Harbor is zoned residential, with a seawall extending over nearly its entire length, and having numerous piers and groins scattered along the area. Within Hampton River there is extensive bulkheading, numerous piers, and several marinas present.

Existing marshes within the Hampton Roads complex are predominantly composed of salt marsh cordgrass (Spartina alterniflora), saltmeadow hay (Spartina patens), salt grass (Distichlis spicata) and other wetlands flora to a lesser degree. Other common plants associated with higher patches of ground will include the marsh elder (Iva frutescens) and the groundsel tree (Baccharis halimifolia). A variety of small mammals may be found associated with the wetlands sites. These areas will also have significant populations of resident and migratory waterfowl and other birds. Population densities will vary and become more diversified where marshes are bordered by undisturbed woodland sections. The marshes and adjacent sand (and mud) flat areas will also contain a variety of invertebrate types, including shellfish. A variety of fish are also present, with many of the local areas serving as spawning and/or nursery sites. Within the rivers, creeks, and in Hampton Roads Harbor are also extensive beds of oysters and clams that are commercially harvested, in addition to blue crabs and various finfish. These shellfish and finfish are important to commercial and recreational fishermen.

INSTITUTIONAL CHARACTERISTICS

Each of the cities operates under a city manager form of government. Citizens elect a council which in turn appoints the city manager. He is given the executive and administrative powers of the government. Council retains the legislative powers.

Virginia Beach, Norfolk, Portsmouth, and Chesapeake are members of the Southeastern Virginia Planning District Commission. Newport News and Hampton are members of the Peninsula Planning District Commission. These commissions have been established by the state to assist in the proper regional development of the areas involved.

POQUOSON, VIRGINIA

PHYSICAL CHARACTERISTICS

The City of Poquoson is located on the Western Shore of Chesapeake Bay in the area known as the Lower Peninsula of Virginia as shown in Figures A-14 and A-15. The main entrance to the city is shown in Figure A-16. The city is bounded on the north by the Poquoson River, a tidal inlet of Chesapeake Bay. There are numerous creeks along the northern shoreline, with Bennett Creek being the largest and most significant harbor. The eastern shore is bounded by a tidal marsh bordering the Chesapeake Bay. This marsh, referred to as Plum Tree Island is about 1.1 miles wide and has ground elevations of less than 5 feet. On the south, the city is bounded by Back River and its Northwest Branch. The mean range of tide is 2.4 feet.

The city is typical of most coastal communities whose existence depends mainly on the sea, in that practically all of the existing development has taken place on the low ground near the edge of the water. Development is along the many creeks and inlets forming the numerous peninsulas. Sixty percent of Poquoson is below elevation 5 feet including many developed areas. This determination is based on U.S. Geological Survey Quadrangle Sheets with five-foot contour intervals. Eighty-five percent of the city is below elevation 7 feet which is the level of the 25-year flood, exclusive of wave action. This determination was made from the folder issued by the Corps and entitled "Floods in the Town of Poquoson, Va., 1971" and the maps it contains. There are no tidal protection projects in the city.

According to the State Department of Planning and Budget (formerly, the Virginia Department of Intergovernmental Affairs), the very nature of shore areas and their uniqueness make them particularly vulnerable to development. The recreational opportunities which exist for swimming, boating, fishing, and other related water sports encourage man to alter these areas through intensive use. There are no dunes along the Poquoson shoreline.

The following excerpts taken from the August 23, 1970 issue of The Daily Press best describe the settlement of Poquoson.

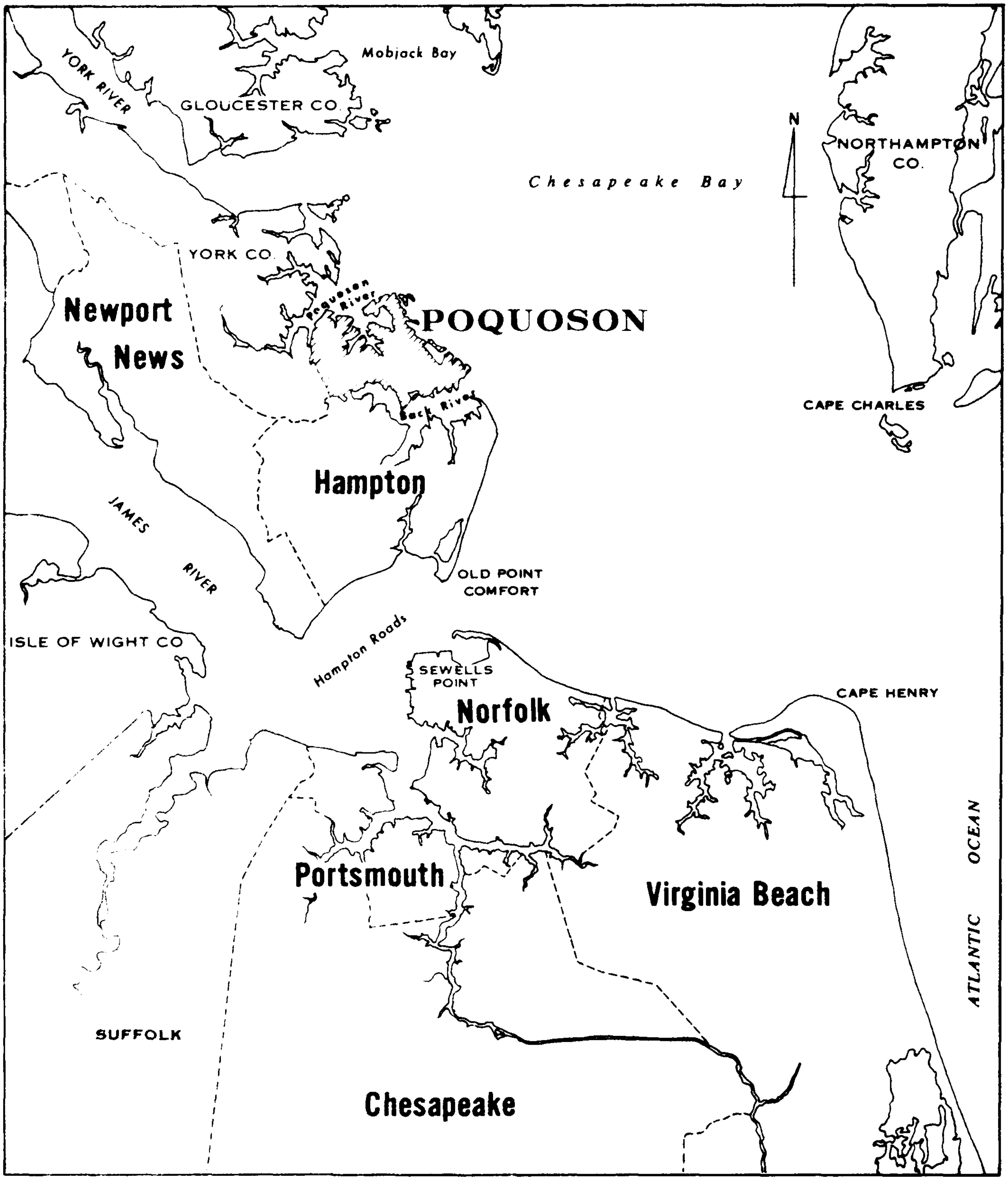


FIGURE A-14 CITY OF POQUOSON AND VICINITY

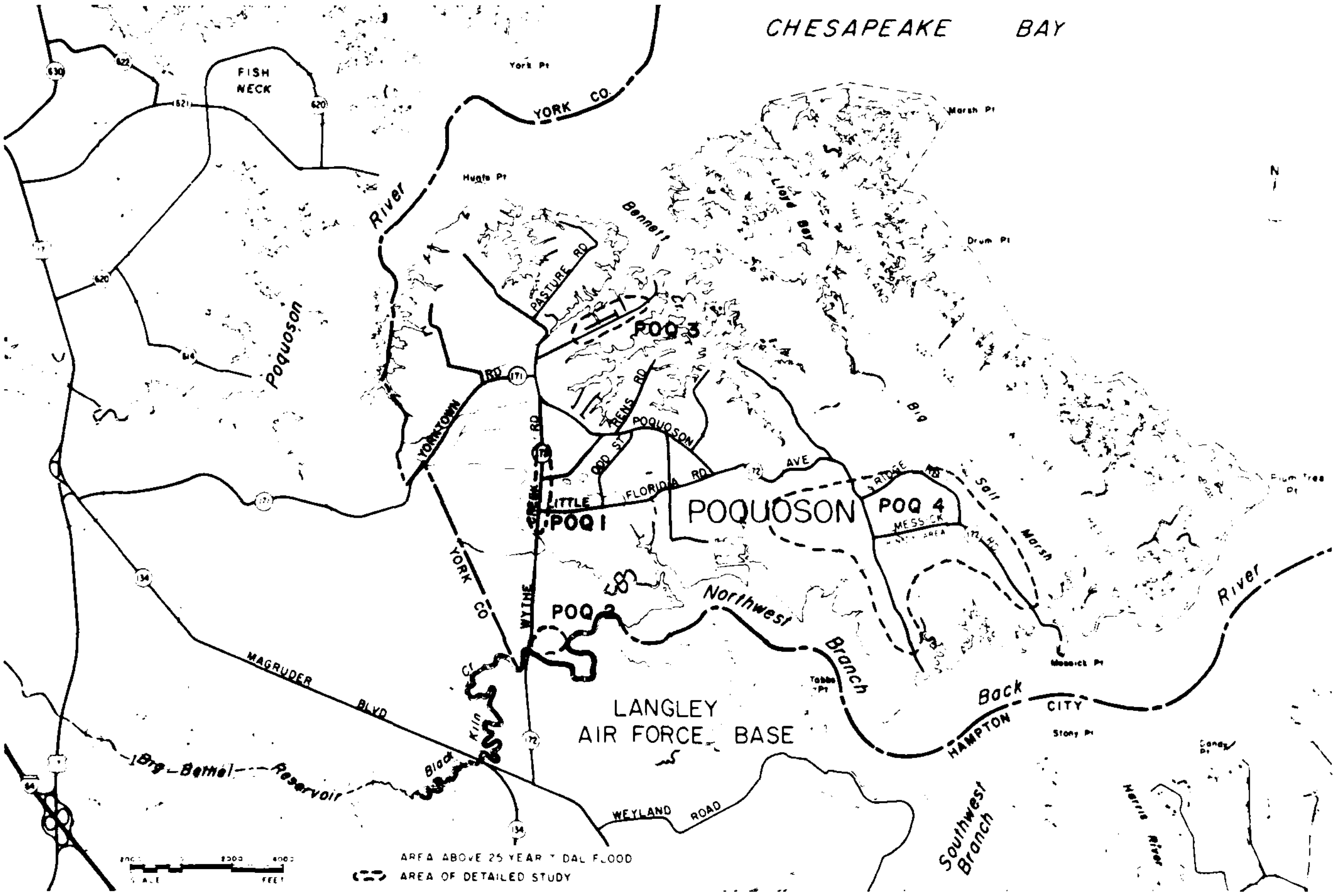


FIGURE A-15 POQUOSON COASTAL FLOODING

FIGURE V-16 AERIAL PHOTOGRAPH OF POQUOSON, VIRGINIA

> Poquoson, a small community strung along the the marshy fringes of the Peninsula's northern shore, has felt the power of the sea.
>
> For 340 years it has existed only for the water, in harmony with the ways of the sea. The people of Poquoson have been shaped by it, taught to live through its ravages, accept its hardships, take their living from its waters.
>
> Historians in the area have concluded that in all probability Poquoson is the oldest continuous English-speaking settlement in America that still goes under the same name. The word Poquoson comes from the Indian for "low, flat land."

Poquoson became a city in 1975. It has been one of the fastest growing cities in the State, the population having increased from 4,278 in 1960 to 5,441 in 1970. The most recent census showed a 1980 population of 8,726. The city is primarily residential in character. The seafood industry has continued to decline in importance since World War II. Most people in the area now work in the Newport News Shipyard, NASA, Langley Air Force Base, and in the many industries located on the Lower Peninsula. Thus, the city mainly serves as a residential base for citizens who commute to jobs in the nearby larger cities, military bases, and Government installations.

Water for the entire city is provided by municipally treated water purchased from the City of Newport News. According to the former Assistant City Manager, of the 3,000 homes in Poquoson, in 1980 about 1,400 were serviced by city sewerage piping tied into the Hampton Roads Sanitation District. The remaining 1,600 were serviced by septic tanks or privies.

The lack of railroads and an airport in Poquoson has caused the city to rely on private and commercial motor vehicles for the movement of people and goods. Most of the primary routes and collector streets have narrow rights-of-way and pavement width.

ENVIRONMENTAL CHARACTERISTICS

Poquoson is bordered by the Poquoson River to the north, the Plum Tree Island Wildlife Refuge to the east, and the Northwest Branch of the Back River to the south. This area contains numerous creeks, coves, and an extensive salt marsh region associated with the Poquoson and Back Rivers which enter the lower Chesapeake Bay. To the west is higher ground where natural woodlands and agricultural land is prevalent.

Poquoson's roads are like an arterial system where numerous side roads extend into "necks" of land separated by small creeks. These creeks result in an extensive amount of shoreline and adjacent salt marsh area.

Residential homes predominate throughout the area and in the nearshore locations. Many of the roads that lead into the marshes will terminate at the farthest extent of the neck in a pier facility, catering to both commercial and recreational boats. Additional private docking facilities are common within the various creeks adjacent to residential property. However, there is very little bulkheaded property. The most extensive amount was found at the entrance to White House Cove and along a dead end canal at Cedar Landing.

Bennent Creek is the major waterway entering from the Poquoson River that leads to the various creeks of northside Poquoson. Beginning at Poquoson Shores at Hunts Neck, there is an extensive tidal flat with fringing marsh areas scattered along the shoreline. Scattered sandy beaches and occasional piers may be seen. This pattern extends into Roberts Creek where the prominent wetlands vegetation is saltmarsh cordgrass (Spartina alterniflora), saltmeadow hay (Spartina patens), and salt grass (Distichlis spicata). Occasional mud flats and patches of black needlerush (Juncus roemerianus) were also present, with marsh elder (Iva frutescens) and the groundsel tree (Baccharis hamilifolia) scattered at sites along higher ground. Approximately 16.3 acres of salt marsh border Roberts Creek (Silberhorn, 1974). Additional marshes are located along Griffins Beach and at Bay Point.

A similar composition of marsh vegetation is found along Lyons Creek (12.9 acres), White House Creek (11.8 acres), Floyds Bay (5.75 acres), and Bennett Creek (52 acres). The Marine Resources Commission publication, "Wetlands Guidelines", characterized the saltmarsh cordgrass community found in this area as very important, with an annual production of four to ten tons per acre. The marsh represents a significant food source to the local ecosystem and acts as a flood buffer and sediment trap. Where the dominance of Spartina alterniflora diminishes, a more mixed brackish water community is found common to this area. When this occurs, there is more diversity in vegetation, habitats, and the fauna present.

East of Bennett Creek and the City of Poquoson is the Plum Tree Island Wildlife Refuge. This area, which was formerly a military practice bombing range, represents the largest salt marsh in the lower Chesapeake Bay, with an acreage of 4,103 acres (Silberhorn, 1974). The shoreline includes mainly salt marsh vegetation, with sandy beaches and mud flats also present. Saltmarsh cordgrass predominates in the intertidal area with saltmeadow hay, saltgrass, and black needlerush also forming extensive stands in the more central locations. The higher ground contains stands of salt bushes, with well established loblolly pine and other vegetation on several ridges in the refuge. Between Messick Point and Tin Shell Point is an extensive Spartina marsh. The southern shoreline of Poquoson from Tin Shell Point continues as an irregularly shaped boundary consisting of fringe and embayed marsh to Brick Kiln Creek.

Beach erosion for the shoreline extending from Tin Shell Point on the Back River, around Plum Tree Island Wildlife Refuge, to Bennett Creek is considered moderate, but noncritical with no structures in danger (Anderson, et al., 1975). However, a severe rate of erosion is taking place between Hunts Point and Griffins Beach along the western side of the entrance to Bennett Creek. Here, erosion rates are 3.6 feet per year.

Poquoson is bordered on the west by an extensive acreage of natural woodland. The city is scattered over a large area with no central area or city complex. This condition results in additional acreage of woodland and land in various types of agricultural use between parts of the city. However, the city is in a phase of burgeoning growth with numerous residential homes under construction throughout the city which infringe into the wooded sections. The natural wildlife is abundant in both the terrestrial and shoreline areas. Of major significance is the Plum Tree Island Wildlife Refuge. Vast in size, this area is mainly salt marsh with stretches of well established pine growth on the higher ridges within the refuge. Resident and migratory waterfowl are abundant within this area, in addition to a wide assortment of mammals and other fauna.

INSTITUTIONAL CHARACTERISTICS

Poquoson has a city manager form of government. Citizens of the city elect a council that appoints the city manager. He is given the executive and administrative powers of the government. City Council retains the legislative powers. Poquoson also has a local planning commission.

A zoning ordinance and subdivision regulations have been enacted by the city and they are revised periodically. All new buildings and additions to existing buildings must now be built with ground or first floor level at an elevation varying from 7.7 to 8.5 above mean sea level.

TANGIER ISLAND, VIRGINIA

PHYSICAL CHARACTERISTICS

Tangier is an island, 3.5 miles long and 1 mile wide, located in the lower half of Chesapeake Bay, as shown in Figures A-17 and A-18. An aerial photograph is shown in Figure A-19 The town is part of Accomack County. Access to the island is by airplane or by one of the vessels that runs frm Crisfield, Maryland, or Reedville, Virginia. The 771 inhabitants live on three ridges on the island known as West Ridge, Main Ridge, and Canton Ridge. Their homes are wood frame construction or trailers. The residents usually earn their living from the sea. This includes sport fishing and shell fishing including an extensive crab industry. There is considerable local boat traffic and several vessels offer cruises to Tangier.

Utilities are provided on the island. The sewerage system consists of individual septic tanks from each home. Problems occur during high tides in the operation of the septic tank units and odors result. A new sewer system with a 0.1 MGD wastewater treatment plant was scheduled to begin operation in late 1983. This should help to eliminate these problems. The telephone system is linked to the mainland by a microwave tower. Electricity is transmitted from Accomack County by submerged cable. Backup generating power is provided by four Chicago Pneumatic Diesel Engines turning General Electric generators rated at 250 kw each. The narrow roads are maintained by the county and state, however, transportation on the island is primarily by walking. Drinking water is provided by wells about 900 feet deep. Heating for homes and businesses is provided by individual home heating units.

ENVIRONMENTAL CHARACTERISTICS

Tangier Island is located in the Chesapeake Bay approximately 11 miles from the Virginia eastern shore and 14 miles from Crisfield, Maryland. It is part of Accomack County, Virginia. Tangier Island was discovered in 1607 by Captain John Smith, but it was not until 1670 that a settlement was established on the island. At that time the island was apparently larger than it is today, having a greater east-west width, with more land extending westward at least 0.5 mile to the Bay side (Wilson, 1980). Extensive acreage was used for agriculture and cattle grazing during the 18th and 19th centuries, in addition to the presence of natural woodlands. During the War of 1812, the British stationed between 12,000 and 14,000 troops on the island and used it as their base of

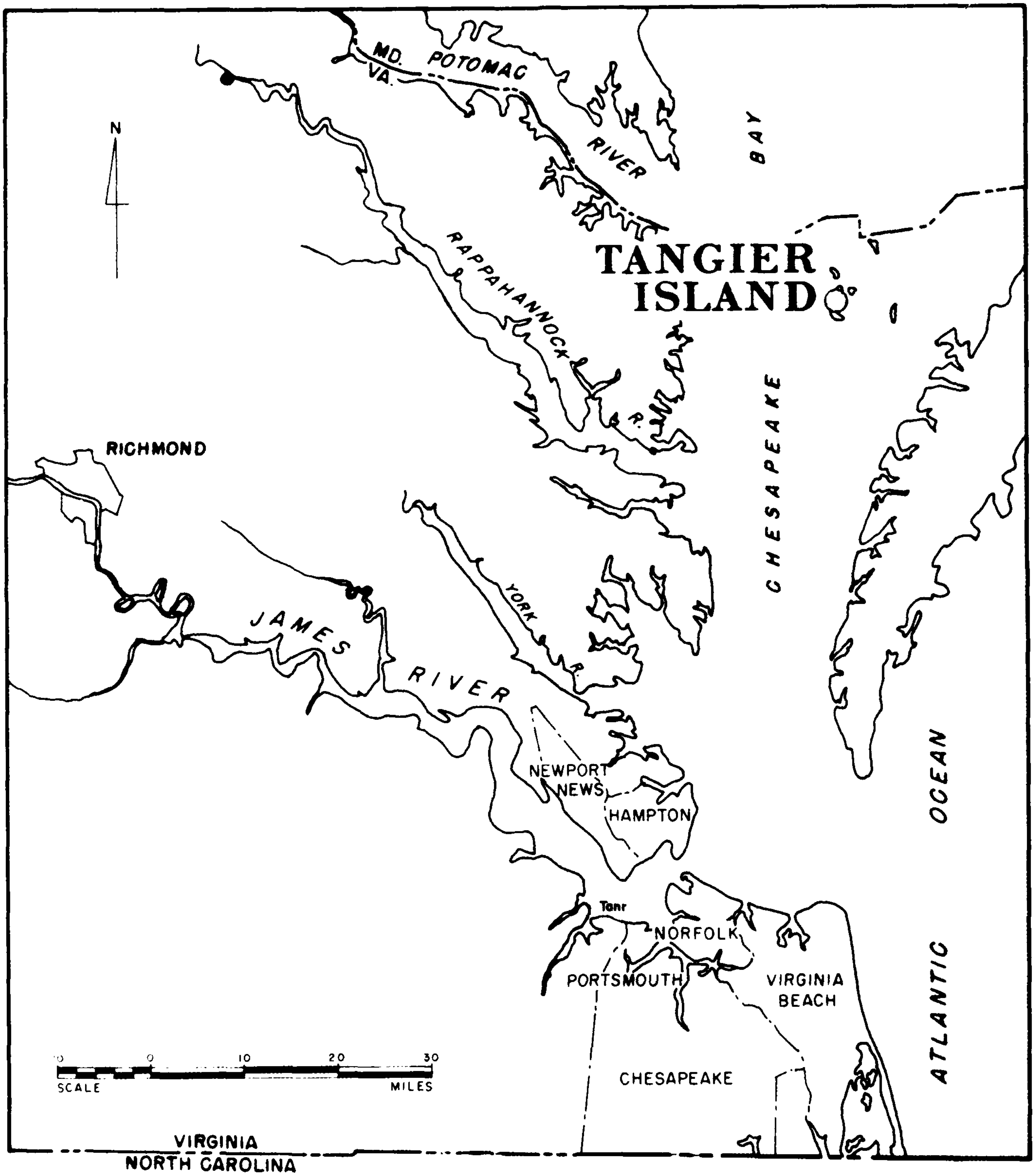


FIGURE A-17 TANGIER ISLAND AND VICINITY

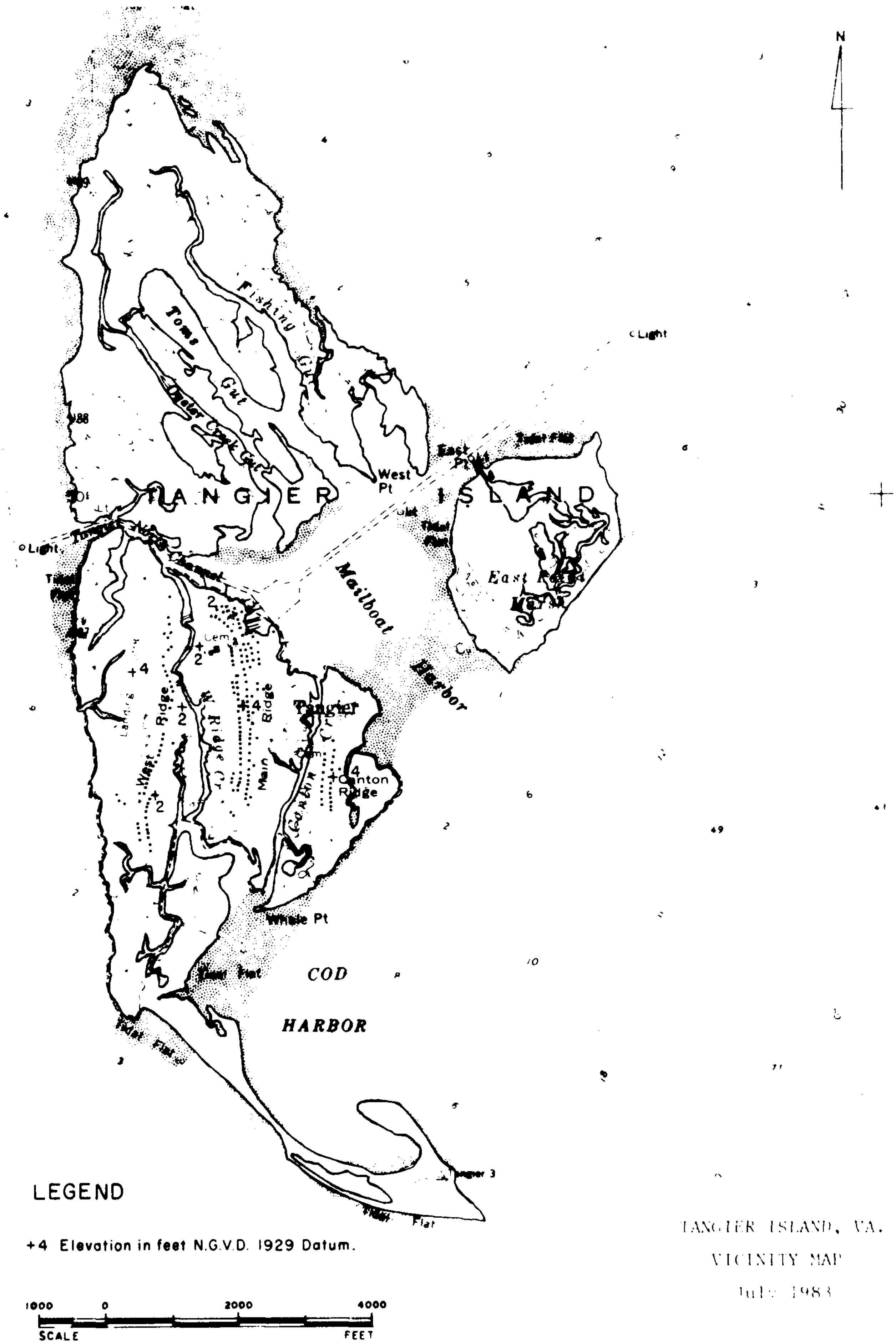


FIGURE 18 MAP OF TANGIER ISLAND

FIGURE 19 AERIAL PHOTOGRAPH OF TANGIER ISLAND, VIRGINIA

operations for several years. Much of the woodlands was destroyed during this period and the area has never recovered. Since that time, the island's land area has continued to decrease due to erosion. Families now depend on the various marine-related activities for a livelihood.

Tangier Island is triangularly shaped and is composed of three distinct bodies of land. The two larger components lie along a north-south axis, approximately 2.8 miles long, divided about mid-point by the Tangier North Channel, with the entire island 1.6 miles in width. To the east and adjacent to Mailboat Harbor is the third portion, identified as East Point Marsh. The approach to Tangier North Channel is from the west leading to Mailboat Harbor. Another channel enters this area from the northeast between Tangier Island and East Point Marsh. The section north of the Tangier North Channel (Tangier North) is approximately 431 acres in size of which 393 acres is marsh interspaced by several large waterways (guts) that open to the southeast and isolated areas of open water. The dominant marsh plants include saltmarsh cordgrass (Spartina alterniflora), black needle rush (Juncus roemerianus), and saltmeadow hay (Spartina patens). Along higher ground in the marsh are scattered stands of the groundsel tree (Baccharis halimifolia) and the marsh elder (Iva frutescens), along with other characteristic plants of a saltmarsh habitat. The near shore waters along the west and northeast margins are shallow. To the west the water depth increases to approximately 30 feet over a distance of three-four nautical miles. Wave action along the western margin of Tangier Island North is the cause of severe erosion to this shoreline.

East Point Marsh is a small marsh island of about 110 acres. It contains a few buildings, a large disposal area, and approximately 67 to 80 acres of saltmarsh interspaced with numerous standing ponds and small creeks. Along the northeastern side of this island, severe shore erosion has been taking place. Waters that are of shallow and intermediate depth along the island's eastern margin become deeper within a mile, with depths increasing into Tangier Sound.

The most developed and populated portion of the Tangier Island group is that area located south of the Tangier North Channel (Tangier South). Consisting of approximately 385 acres, Tangier South is characterized by three parallel ridges that are bordered and separated by low land saltmarsh. The roads, various buildings, and all the houses have been constructed on these higher elevated ridges. The island's docking facilities and piers are located at the north end of the central (main) ridge, with an airplane landing strip located west of and parallel to the west ridge. Between the three ridges are two creeks that extend across the length of the island. These creeks are further divided into various waterways into the marsh. After a rain, there is additional standing water within the marshes between the ridges. Access across the creeks, from one ridge to anotner, is made possible by several bridges. The southern end of this island is basically all saltmarsh and tidal flats with a sand spit extending from the western margin to form Cod Harbor.

As indicated above for the Tangier North section, the nearshore area of the Tangier South section is bordered by shallow waters to the west, with deeper waters directly to the east and south. There are low shorelines, consisting of marshes along the east, south, and west margins. Along the west side, wave action has resulted in an extensive loss of land and the erosion rate is described as critical in the Shoreline Situation Report for Accomack County (Hobbs, et al., 1974). Citing comparisons made from 1942 and 1968

USGS topographic quadrangles, estimates of an average rate of loss of 13 feet per year are given for the western shore and 10 feet per year for the northeast margin of East Point Marsh Island. Subsequent comparisons of recent aerial photographs and the 1968 quadrangle indicate the rate has increased to 27 feet per year at shoreline locations adjacent to the southern end of the landing strip, plus the southern end of West Ridge. At this rate, adjacent marshland will be endangered.

SOCIO-ECONOMIC CHARACTERISTICS

Today the residents of the island are still engaged principally in the seafood industry. Seafood grounds in the vicinity of the island produce excellent catches of oysters, clams, and crabs. During summer months, soft crabs are sold to both local and out-of-state markets. In the winter months, the oyster industry is the dominant source of income although a few of the residents dredge crabs during this time. Many of the small businesses provide services related to the commercial fisheries. There is one municipal dock, a marina with railway, and several privately owned docks and crab sheds. Reported tonnage of shellfish landed in Tangier varied from 441 tons in 1977 to 1,491 in 1979; 771 tons were landed in 1981.

There is an air strip on the island, but people are largely dependent upon water transportation for commodities such as fuel and groceries. Although there is commerce with both the Maryland and Virginia shores, the island mail is received and dispatched through Crisfield, Maryland, where many residents have relatives.

Vessels carrying dry cargo and 18,640 passengers made 2,121 trips to and from Tangier in 1981. Some of these passengers were visitors from Crisfield, Maryland, or Reedville, Virginia, coming for the day. An inn provides meals and rooms for overnight guests. This tourism provides additional employment and income for the islanders.

One school on Tangier provides education for all grades through high school. The 1980 census population was 771, down from 814 in 1970. Population growth is not likely in the future as both land area and job opportunities are limited.

INSTITUTIONAL CHARACTERISTICS

Accomack County has a county administration form of government and is divided into five election districts. A nine-member county board of supervisors is chosen from these districts. The area is served by the Accomack-Northampton Planning District Commission. It consists of 12 members. There is also the Eastern Shore Soil and Water Conservation District, governed by a six-member board of directors. Tangier functions with a mayor and five-member council.

WEST POINT, VIRGINIA

PHYSICAL CHARACTERISTICS

West Point, an incorporated town with a 1980 population of 2,726, is located in King William County on the west side of Chesapeake Bay. It lies at the confluence of the Mattaponi and Pamunkey Rivers and the upper end of York River, 33 miles upstream from Chesapeake Bay, as shown in Figures A-20, A-21 and A-22. The mean range of tide is 2.8 feet.

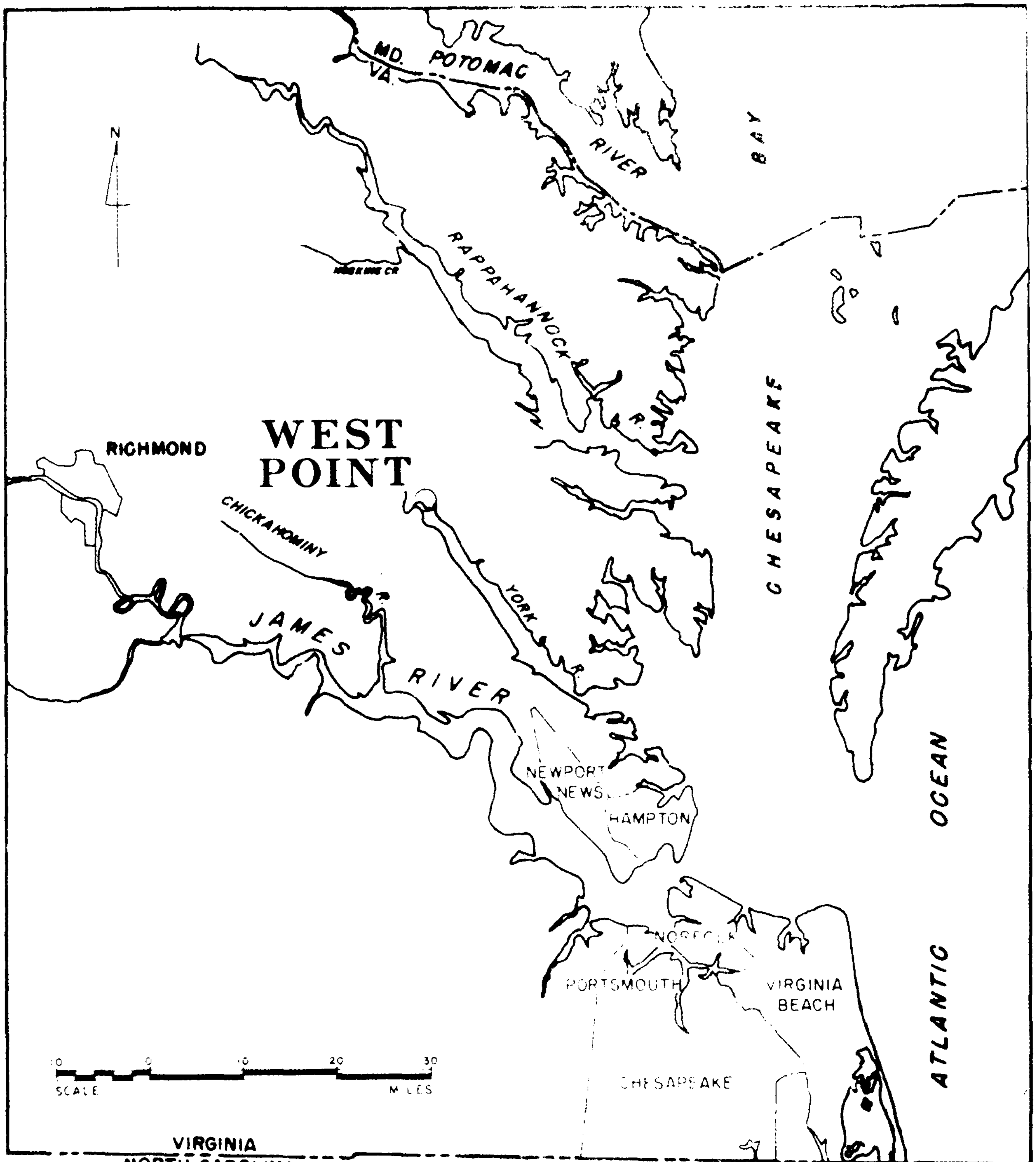


FIGURE A-20 WEST POINT AND VICINITY

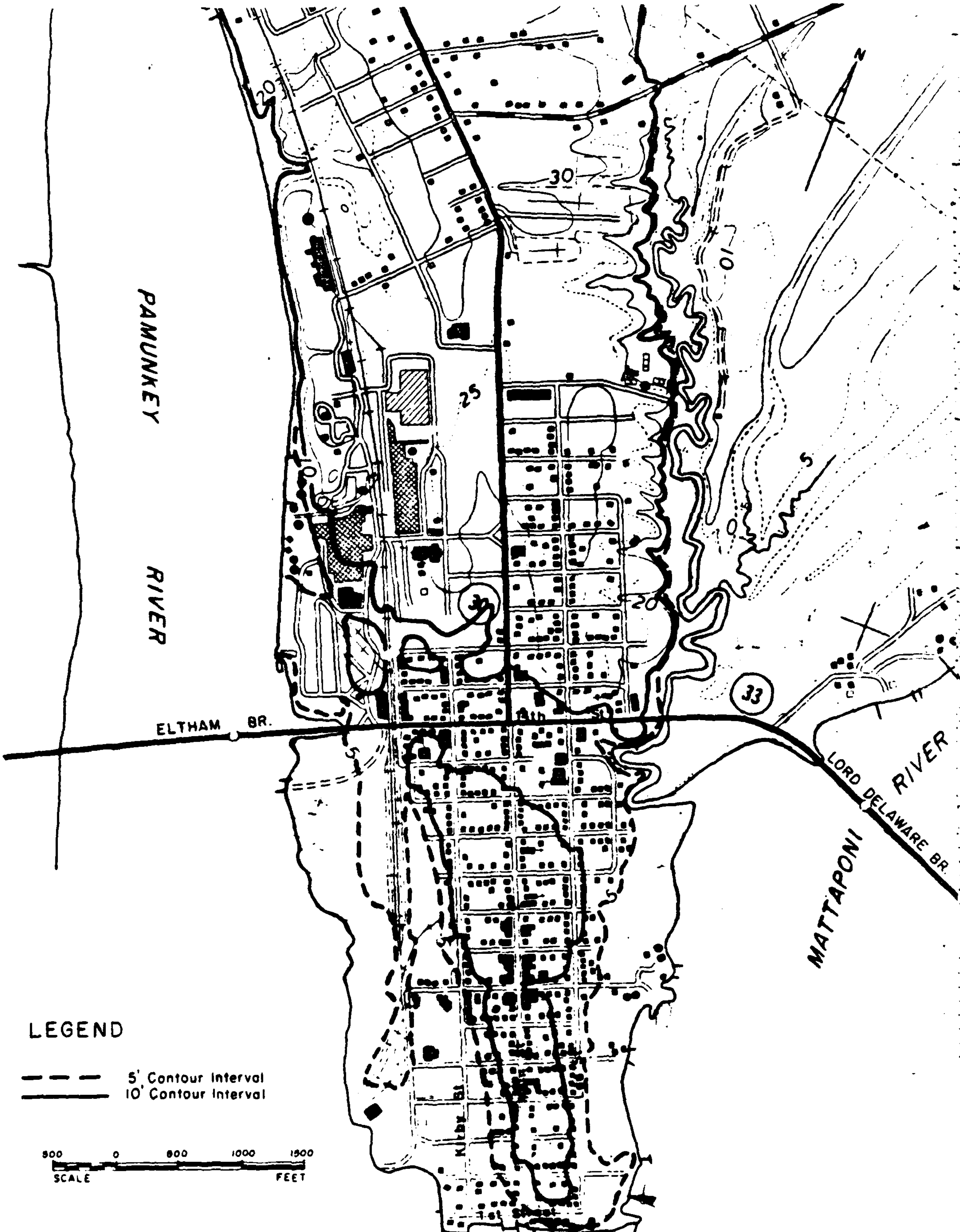


FIGURE A-21 WEST POINT AREA FLOOD MAP

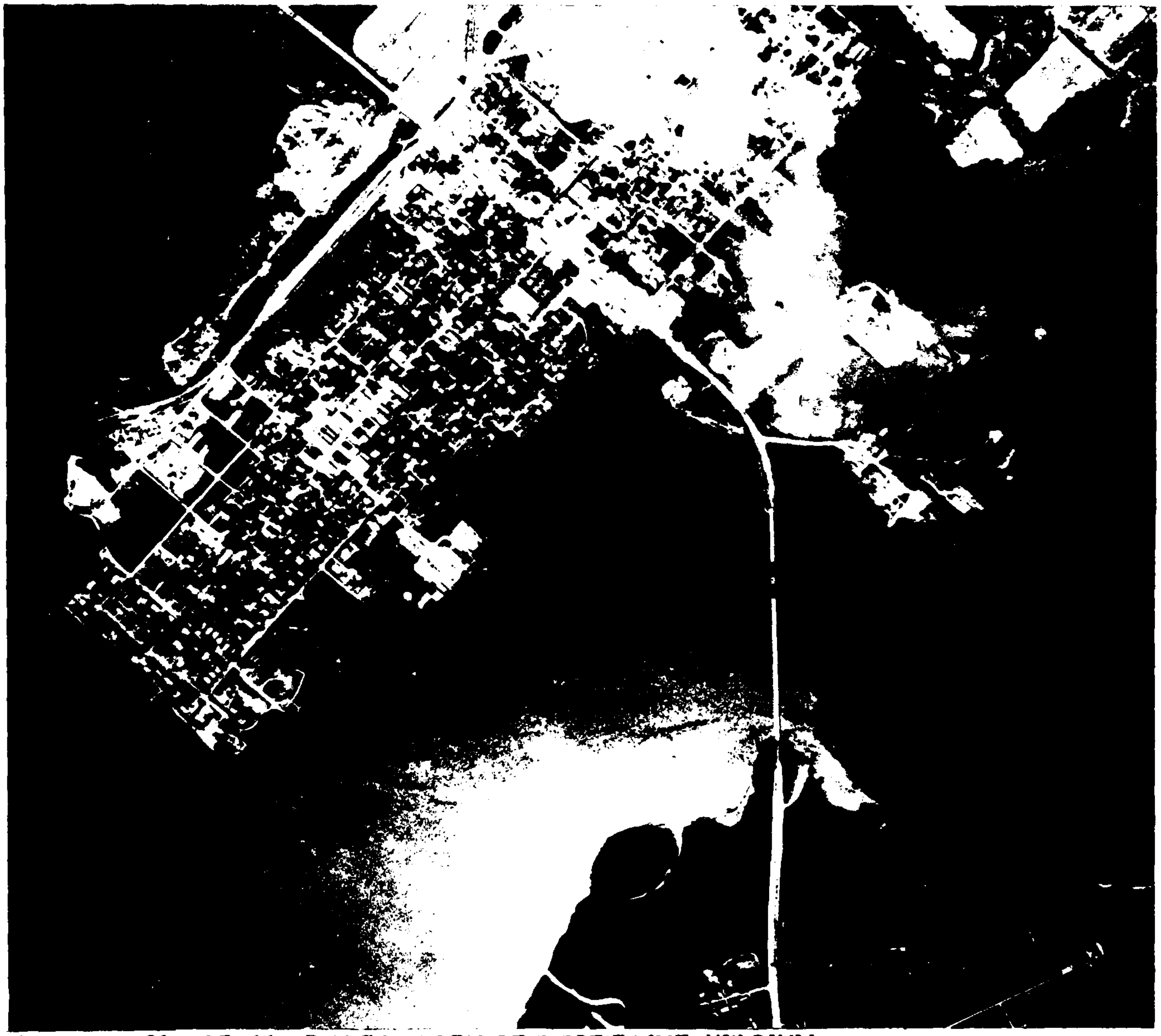


FIGURE A-22 AERIAL PHOTOGRAPH OF WEST POINT, VIRGINIA

King William County is located in the north central portion of the Tidewater section of Virginia in what is sometimes referred to as the Middle Neck. The county is rural; three-fourths of the land is forested and practically all the remaining area is farmland. King William contains the only Indian reservations in Virginia-the Mattaponi and Pamunkey.

West Point is a wholesale and retail trading center for the area. It is also the nucleus of an industrial complex which includes a large paper manufacturing plant - the Chesapeake Corporation of Virginia. It occupies the left bank of the Pamunkey River from 14th Street north for about 0.8 mile. The plant is now and has been the most important employer in the area since before 1950. It employed almost 1,000 persons in 1981 and manufactures paperboard and paper. Old Dominion Grain and Fertilizer is the next largest industry employing 50 to 95 persons. The Virginia Logging Company, which produces veneer wood, and the West Point Logging Company, which buys and sells logs that are used for veneer, are the only other manufacturing activities of significance in West Point. They employ, respectively, about 44 and 4 people.

West Point connects with Interstate 64 by Virginia Highway 33, a four-lane concrete road 8 miles long that crosses both the Mattaponi and Pamunkey Rivers. Water to the town and to the Chesapeake Corporation is supplied by wells. The sewerage system includes secondary treatment for both the Town of West Point and the Chesapeake Corporation. Power is supplied by the Virginia Electric and Power Company.

ENVIRONMENTAL CHARACTERISTICS

As previously stated, West Point is located at the confluence of the Pamunkey and Mattaponi Rivers, which unite to form the York River. Jutting into this river complex, a large portion of the city is surrounded on three sides by water. To the north and landward, there exists a general rural setting with woodlands, agricultural lands, a few roads, and limited residential development. Common field crops include corn, soybeans, wheat, and other grains. Local timberland owners develop large amounts of Loblolly and Virginia pine, which are sold as sawtimber, piling, and pulpwood. The low land bordering the river system contains large areas of wetlands. The shoreline around the city also contains patches of wetlands marsh, plus stretches of bulkheaded property. Piers and docking facilities are also scattered around the shoreline.

The effects of industrial, railway, and shipping activities are most noticeable along the city's eastern shoreline of the Pamunkey River. North of Eltham Bridge on Virginia Highway 33, an extensive bulkheaded docking facility has been constructed by the Chesapeake Corporation. South of this bridge, the railway yard and complex extends to a small pier facility. Here the marsh is well developed and represents a significant amount of this shoreline. The southern shoreline of the city faces the York River and consists of bulkheaded property containing residential housing. Some shoreline reinforcement by concrete and riprap extends along the property into the Mattaponi River. Additional pier facilities are present along this eastern shoreline with several buildings and storage tanks located in the area. Fringe and more extensive marsh acreage is present to West Point Creek and beyond to Lord Delaware Bridge on Virginia Highway 33. Moving farther up the Mattaponi River, large stands of salt marsh vegetation and fringe sections occur on both sides of the river.

A similar situation of considerable marsh development is present along the Pamunkey and upper York Rivers. At these sites, alternate sections of fringe marsh with broad patches of marsh areas are common. A few pound net stakes may be seen in both the lower Mattaponi and Pamunkey Rivers, but no extensive fishery was noted. Accretion, at a rate of approximately 1.3 feet per year, is estimated along the eastern shoreline of West Point. However, along the western shoreline, there is slight erosion of 0.8 feet per year between Eltham Bridge and the southern end of the city (Hobbs, et al., 1975).

The York River in the vicinity of West Point has been classified as "Water Quality Limiting" (Water Quality Inventory, 305b Report, 1982). In the past this segment has not met water quality standards and 305(b)(1)(B) criteria because of high fecal coliform levels from undetermined sources.

INSTITUTIONAL CHARACTERISTICS

Politically, King William County is divided into five election districts and from each of these a representative is elected to the county Board of Supervisors - the controlling body of the county's government. West Point, the only incorporated town in the county, is governed by a mayor and a seven-member town council. Since the town is considered a part of the county, the ordinances and regulations of the county are effective in West Point.

ALTERNATIVE FUTURE CONDITIONS

In order to project the future one must examine the past. The economic history of the Bay area is not too unlike that of many other urban areas throughout the world. Early growth and development occurred in those areas that provided transportational advantages for both imports and exports. Growth generally spread from these urban areas as land based transportation improved and the resources of the surrounding area were developed. More recently, the growth of suburbia resulted in the decline of the central cities and, interestingly, in the movement of people from the rural areas to where employment could be obtained.

Examining recent trends the population of the Chesapeake Bay Region increased 23.2 percent during the 1960-1970 decade. This was significantly higher than the National rate of 13.3 percent and higher than 43 of 50 states. The largest population increase in the region occurred in the Washington D.C. and the Baltimore subregions as the migration to the suburban counties continued. There is every indication that these past trends will continue; however, the rate of growth is not expected to be as high.

As it relates more directly to the Chesapeake Bay Tidal Flooding Study the majority of the communities under study are located in rural counties where the growth has been and is likely to continue to be limited at best. In order to better formulate and evaluate alternative plans of improvement in these communities studies were made to define alternative future conditions. A more detailed discussion of these studies and the resultant impacts may be found in Appendices B, E and F. The following paragraphs provide an overview of the future conditions that would be expected both "with" and "without" a Federal project.

WITHOUT PROJECT CONDITIONS

Generally speaking, the most likely "without project" future conditions will be very similar in all the communities selected for detailed study. Based on the more detailed socio-economic studies reported in Appendices D and F it appears that growth in the majority of these communties will be much slower than in the suburban counties surrounding or comprising the Region's Standard Metropolitan Statistical Areas (SMSA). It should be noted that the future growth in the flood-prone communities does not appear to be significantly influenced by the potential for tidal flooding. Based on discussions with local officials and the general public, there is generally widespread apathy about the seriousness of tidal flood problems.

This apathy is believed to be the result of the long period of time since a tidal flood of major proportions occurred and also a certain degree of acceptance of tidal flooding as a fact of life for those residents who live on the shoreline and depend on the Bay for their livelihood.

In the absence of one or more severe tidal floods or an extensive public awareness program it is doubtful that the aforementioned attitudes will change significantly. It is expected that the flood-prone portions of the communities will continue to suffer periodic "nuisance" flooding without suffering severe socio-economic impacts. The most likely future collective flood prevention actions will be nonstructural in nature and probably consist of flood plain zoning measures that have been adopted as a result of the Flood Insurance Program. All the communities studied are included in the Flood Insurance Program. To a limited extent, floodproofing measures will also be employed where new construction is required by local ordinance to exceed a specified flood elevation. Finally, with regard to nonstructural measures, it is expected that flood warning and evacuation plans will be developed and/or refined by local and state agencies. The development of these plans will be aided through the National Oceanic and Atmospheric Administration's (NOAA) Coastal Hazards Program. Under this program a Regional Hazard Operational Plan is tentatively scheduled to be prepared for the Chesapeake Bay area in the late 1980's.

With regard to structural protection, bulkheading has historically been used by both individuals and local government as a means of shoreline erosion protection. It is likely that this measure, which does provide at least a small degree of flood protection in some cases, will continue to be used in the future.

In summary, the "without project" conditions could perhaps best be described in most of the communities as a continuation of the "status quo" with limited future economic growth. Future flood protection will generally be limited to nonstructural measures that result from either local or individual actions unless future flood occurrences are of such a magnitude that prevailing attitudes are changed.

WITH PROJECT CONDITIONS

Detailed studies of the impacts of various flood control measures were conducted in each of the communities. The detailed results of these studies are presented in Appendices B and F. The following is a general discussion of the results of these studies.

Under the with project conditions, the adverse impacts associated with varying levels of flooding would be eliminated after the year 1990 which is the assumed construction date of a justified project. Elimination of the flood threat should improve the psychological well-being of those residents receiving flood protection. Further, dependent on the type of flood protection measure considered, opportunities for additional recreational or commercial/industrial development would be provided. Additional development as mentioned above would be beneficial to the community from either an environmental or socio-economic standpoint.

It is expected that some adverse impacts would also result from the construction of some of the flood control measures. For example, structural improvements located along the shoreline will limit access to the water and could thus impact to varying degrees on the ability of watermen to pursue their livelihood. From an aesthetic standpoint a levee or floodwall constructed along the shoreline would eliminate or restrict the view of the adjacent waters. Nonstructural measures to include relocation and acquisition and demolition of flood plain development would also be expected to have serious social impacts. These social impacts could best be characterized as disruptions of community cohesion resulting from the displacement of a considerable number of residents.

PROBLEMS AND NEEDS

The problems and needs of those communities selected for detailed study were defined through field and office studies and through communication and coordination with interested Federal, state and local agencies and the public.

The Existing Conditions and Future Conditions reports presented the results of those studies conducted to define the existing and projected needs of the Chesapeake Bay area. Generally speaking, these needs were developed on a subregional basis and not for individual communities. As part of the Chesapeake Bay Tidal Flooding Study, more detailed studies were conducted to define the character and extent of the tidal flood problem only. No additional studies were made to define in detail the other water resources needs of the communities.

Regarding the views and desires of local interests, public input was provided through correspondence and direct communication with Corps officials during visits to the communities and statements presented at the two sets of public meetings. This subject is discussed in Supplement B to the Summary Report-Public Involvement. The following paragraphs provide a description of the tidal flooding problems in each of the communities.

CAMBRIDGE, MARYLAND

As noted earlier, Cambridge is located on the Choptank River approximately 15 miles upstream from the mouth. With elevations ranging from zero NGVD to about 30 feet NGVD some of the low lying areas within the community are subject to tidal flooding. The area that would be inundated by the 100 and 500-year floods is shown in Figure A-23. The 100 and 500-year floods are those floods that are projected to have a 1.0 and 0.2

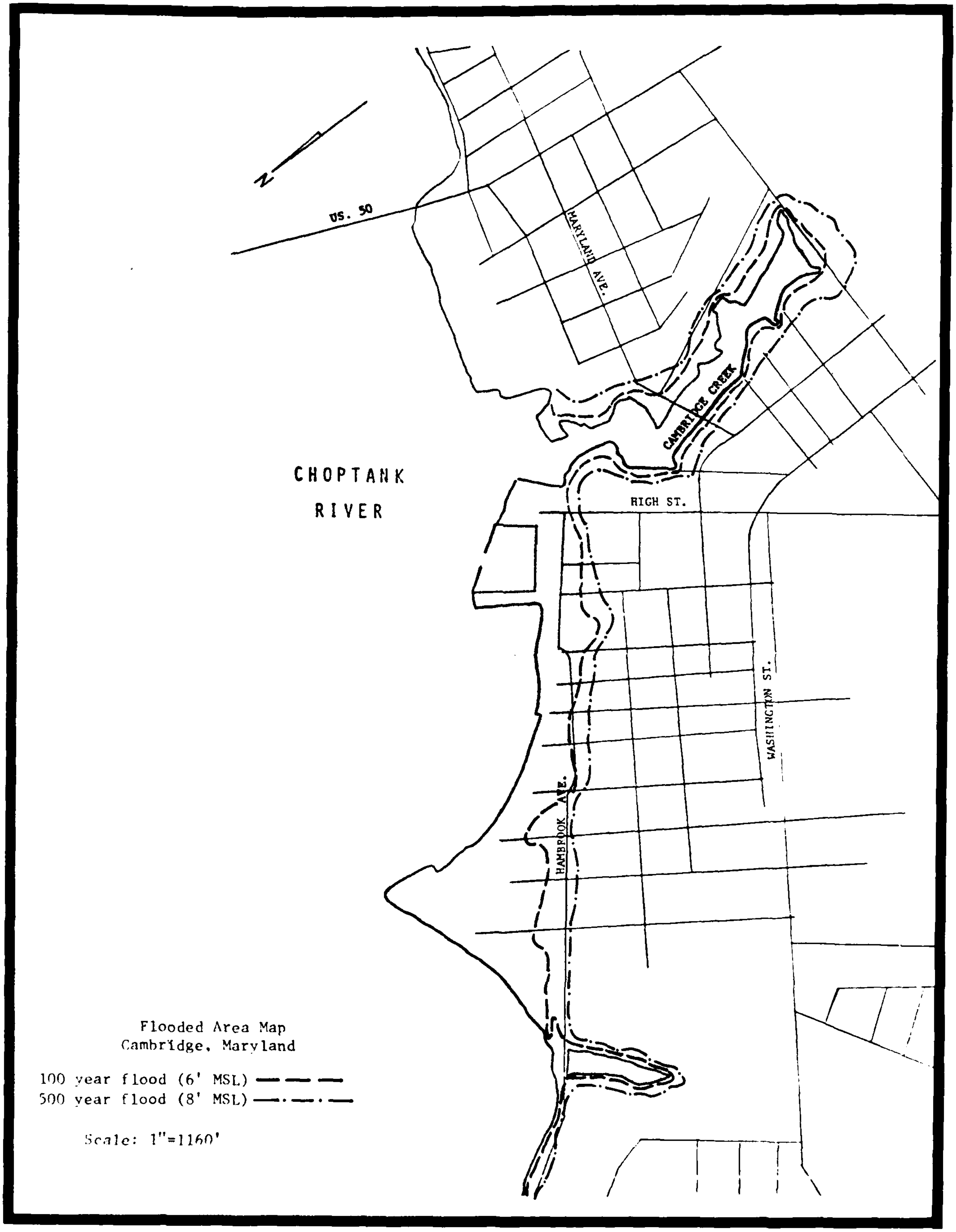


FIGURE A-23 CAMBRIDGE TIDAL FLOOD AREAS

percent chance of occurrence in any one year. It should be noted that the August 1933 flood of record is equal to the 100-year event and that all damage and inundation information for the 100-year flood would be representative of a recurrence of the flood of record.

Table A-11 provides a summary of the area inundated, structures flooded and total damages for both the 100 and 500-year events. Based on the flood damage surveys and the assumed stage-frequency relationship shown in Appendix E - Engineering Design and Cost Estimates the average annual flood damages for the without condition are estimated to be approximately $18,400 (July 1979 dollars).

The desires of local interests were expressed through public meetings, meetings with local officials and discussions with the general public during the conduct of the flood damage surveys. Prior to the completion of the Future Conditions Report, a series of public meetings was held in June 1976 to present the findings of the study and to solicit any additional information from the public regarding Bay-related problems. At the aforementioned meetings, one of which was held in Cambridge, the tidal flooding problems of the Bay area were discussed and those communities designated as critically flood-prone were identified. Those present at the public meetings had no comments relative to tidal flooding in Cambridge. In the fall of 1979 prior to the flood damage surveys a series of meetings was held with the Dorchester County Commissioners, the Mayor of Cambridge and other local officials. The purpose of the meetings was to discuss the Tidal Flooding Study with local officials and to solicit their views on the tidal flooding problem. The results of these meetings are summarized as follows:

1. While local officials acknowledged that Cambridge has a tidal flood problem, they did not believe it was serious.

2. Local officials offered no specific suggestions as to the type or location of flood control measures to be considered; however, it appeared that nonstructural measures would be more acceptable to local interests than structural measures.

3. In response to several questions the relationship between the Corps study and the flood insurance program was discussed.

4. Local officials were very cooperative providing copies of mapping, local planning documents, and advice as to local residents to contact for additional information.

5. Local officials requested that they be advised of study progress and also be provided with copies of study results so that any technical findings relative to levels of flooding could be considered in local planning decisions.

During the course of the flood damage surveys numerous conversations were held with residents of the community. While the majority of these individuals lived in the flood plain, they did not appear to be concerned about tidal flooding. Many of the individuals were disturbed that they had been designated through the flood insurance program as living in the flood plain. Most of these individuals had not previously experienced a major flood and were skeptical as to the limit of flooding. Little information was provided by local interests relative to the character and extent of historical flooding.

TABLE A-11

CAMBRIDGE, MARYLAND, FLOOD DAMAGE POTENTIAL

Percent Chance of Occurrence In Years	Elevation in Feet Above NGVD	Area Inundated in Acres			Number of Structures Flooded				Total Damages ($1,000) (July 1979)
		Developed	Undeveloped	Total	Residential	Commercial	Other[1]	Total	
100	5.9	50	20	70	60	14	2	76	300
500	7.5	120	20	140	139	29	3	171	850

[1] Includes both industrial and public structures.

CRISFIELD, MARYLAND

Located on the Little Annemessex River just off Tangier Sound near the widest portion of the Bay, Crisfield is particularly vulnerable to tidal flooding. The entire community has an elevation of 10 feet above NGVD or less and starts to incur flood damages above elevation 2.0 feet NGVD. The area inundated by the 100 and 500-year floods is shown in Figure A-24. A recurrence of the flood of record (August 1933) is estimated to be a 100-year event and would flood approximately 740 structures and cause $1,800,000 in damages (July 1979 price levels). Additional flood damage-related information is shown in Table A-12. The average annual flood damages for the without condition were estimated to be approximately $142,500.

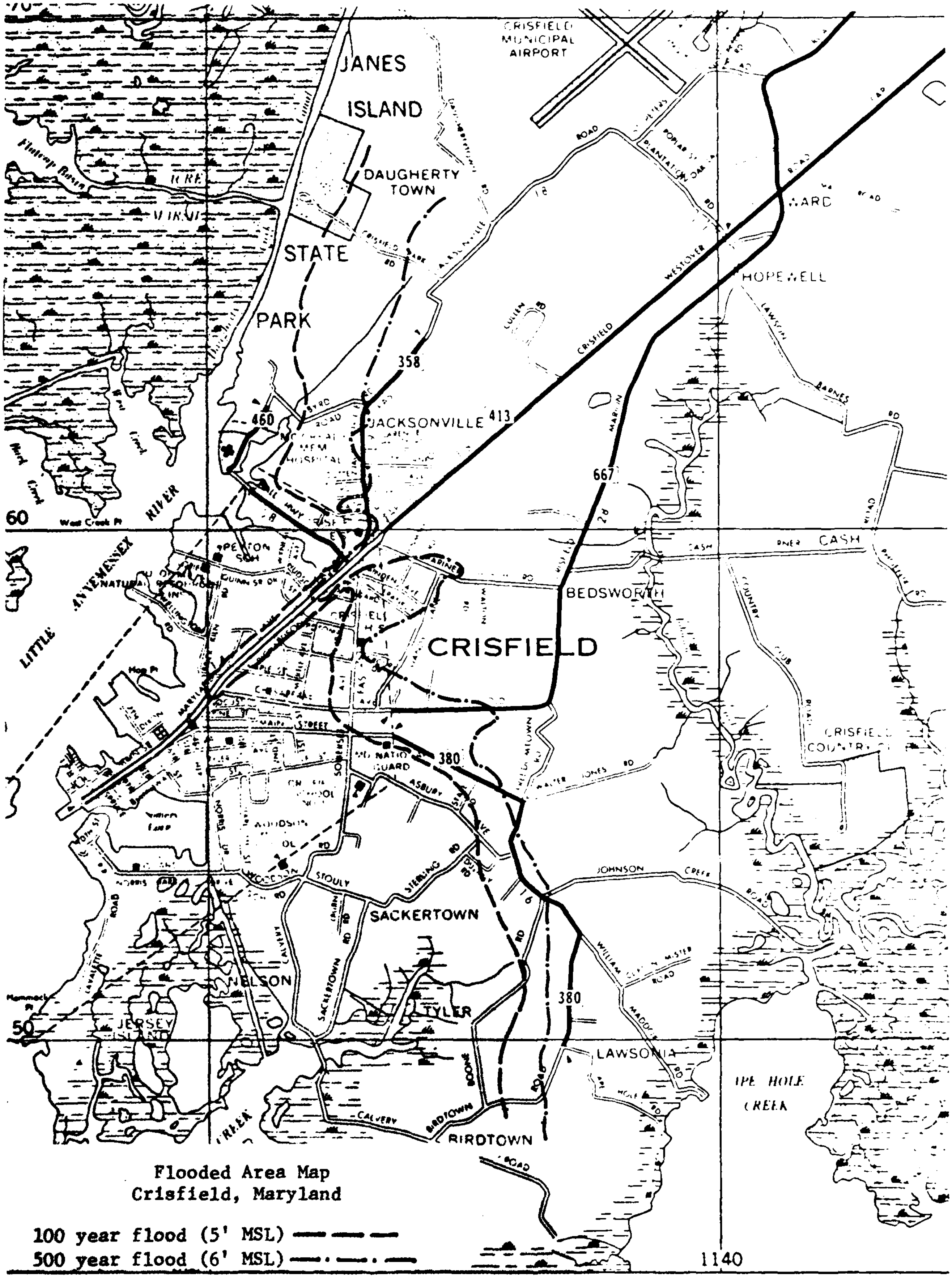
In July 1979, meetings were held with both the Mayor of Crisfield and the Somerset County Commissioners to discuss the tidal flood study and to solicit their views on the community's flood problems. Local officials were knowledgeable relative to the potential for flooding in the community and expressed support for the study. The March 1962 flood was mentioned as the most recent event that had caused significant damage in the community. Local drainage was also mentioned as a problem, particularly when local runoff coincided with normal high tides. No specific suggestions were offered by local interests as to the type or level of flood protection desired. Further, no comments were made relative to tidal flooding in Crisfield at the previously mentioned public meetings.

POCOMOKE CITY, MARYLAND

Pocomoke City is located on the Pocomoke River approximately 12 miles upstream, from the river's entrance into Pocomoke Sound. The community is subject to tidal flooding resulting from storm surges which are translated up the Pocomoke River from Pocomoke Sound and Chesapeake Bay. Elevations within the community range from sea level to approximately 30 feet NGVD with the lowest areas located along the river between Route 13 and McMichael Avenue. The area inundated by the 100 and 500-year floods is shown in Figure A-25.

Information on historical flooding is extremely limited. If it is assumed that the 100-year flood is representative of the August 1933 flood of record, which is generally the case in the Maryland portion of the Bay, then a recurrence of that event would flood approximately 50 structures and cause $350,000 in damages. Additional flood damage related information is shown in Table A-13. The average annual flood damages were estimated to be approximately $23,900 (July 1979 price levels).

Based on a series of meetings held in June 1979, the Worcester County Commissioners and local officials from Pocomoke City supported the tidal flooding study; however, little advice was provided as to the type and/or level of flood protection desired. As in the communities discussed previously, local interests were interested in obtaining the results of any technical studies in order that these findings could be incorporated into local planning decisions.



Flooded Area Map
Crisfield, Maryland

100 year flood (5' MSL) — — —
500 year flood (6' MSL) —·—·—

Scale: 1"=1/2 mile

FIGURE A-24 CRISFIELD TIDAL FLOOD AREAS

TABLE A-12

CRISFIELD, MARYLAND, FLOOD DAMAGE POTENTIAL

Percent Chance of Occurrence In Years	Elevation in Feet Above NGVD	Area Inundated in Acres			Number of Structures Flooded				Total Damages ($1,000) (July 1979)
		Developed	Undeveloped	Total	Residential	Commercial	Other[1]	Total	
100	5.1	680	260	940	564	162	16	742	1,800
500	6.1	910	370	1,280	1,133	193	22	1,348	4,300

[1] Includes both industrial and public structures.

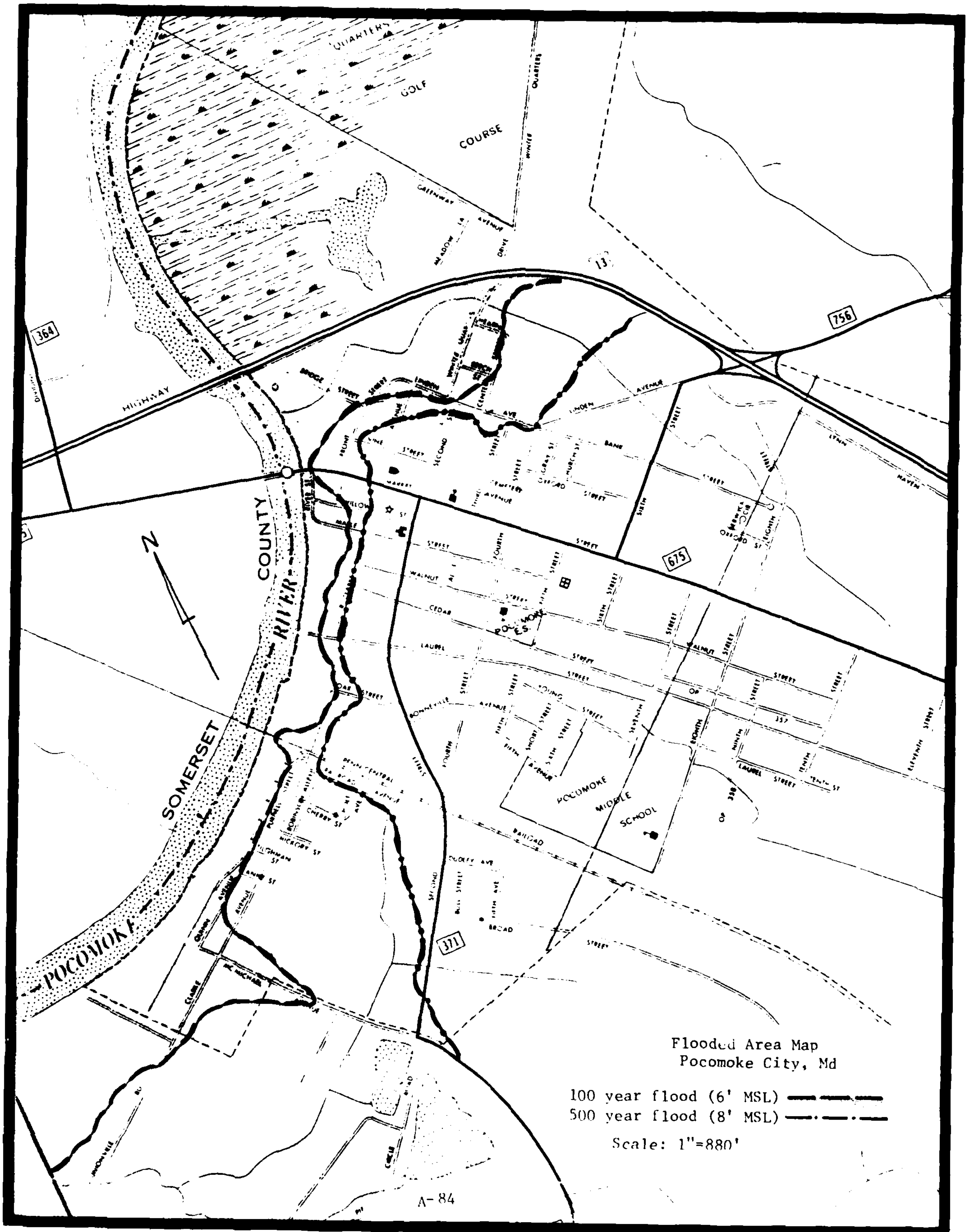


FIGURE A-25 POCOMOKE CITY TIDAL FLOOD AREAS

TABLE A-13

POCOMOKE, MARYLAND, FLOOD DAMAGE POTENTIAL

Percent Chance of Occurrence In Years	Elevation in Feet Above NGVD	Area Inundated in Acres			Number of Structures Flooded				Total Damages ($1,000) (July 1979)
		Developed	Undeveloped	Total	Residential	Commercial	Other[1]	Total	
100	6.3	80	--	80	43	8	1	52	350
500	7.8	140	30	170	145	30	3	178	1,150

[1] Includes both industrial and public structures.

ROCK HALL, MARYLAND

Rock Hall is located in southwestern Kent County on the eastern shore of Chesapeake Bay. With elevations ranging from zero NGVD to approximately 25 feet NGVD a substantial portion of the community is subject to tidal flooding. The area inundated by the 100 and 500-year floods is shown in Figure A-26. It should be noted that the flooding on the east side of town is the result of tides that have been translated up Grays Inn Creek from the Choptank River.

A recurrence of the flood of record (August 1933) is estimated to be a 100-year event and would flood approximately 350 structures and cause an estimated $1,850,000 in damages at July 1979 price levels. Table A-14 includes additional information relative to the flood potential in the community. The average annual flood damages for the without condition were estimated to be approximately $73,500.

Based on a series of meetings held in March and April of 1979, the Kent County Commissioners and local officials from Rock Hall supported the tidal flooding study. However, no specific suggestions were offered as to flood protection measures. There was considerable discussion relative to the Flood Insurance Programs and the status of the Corps study to modify the existing breakwater project (subsequently modified).

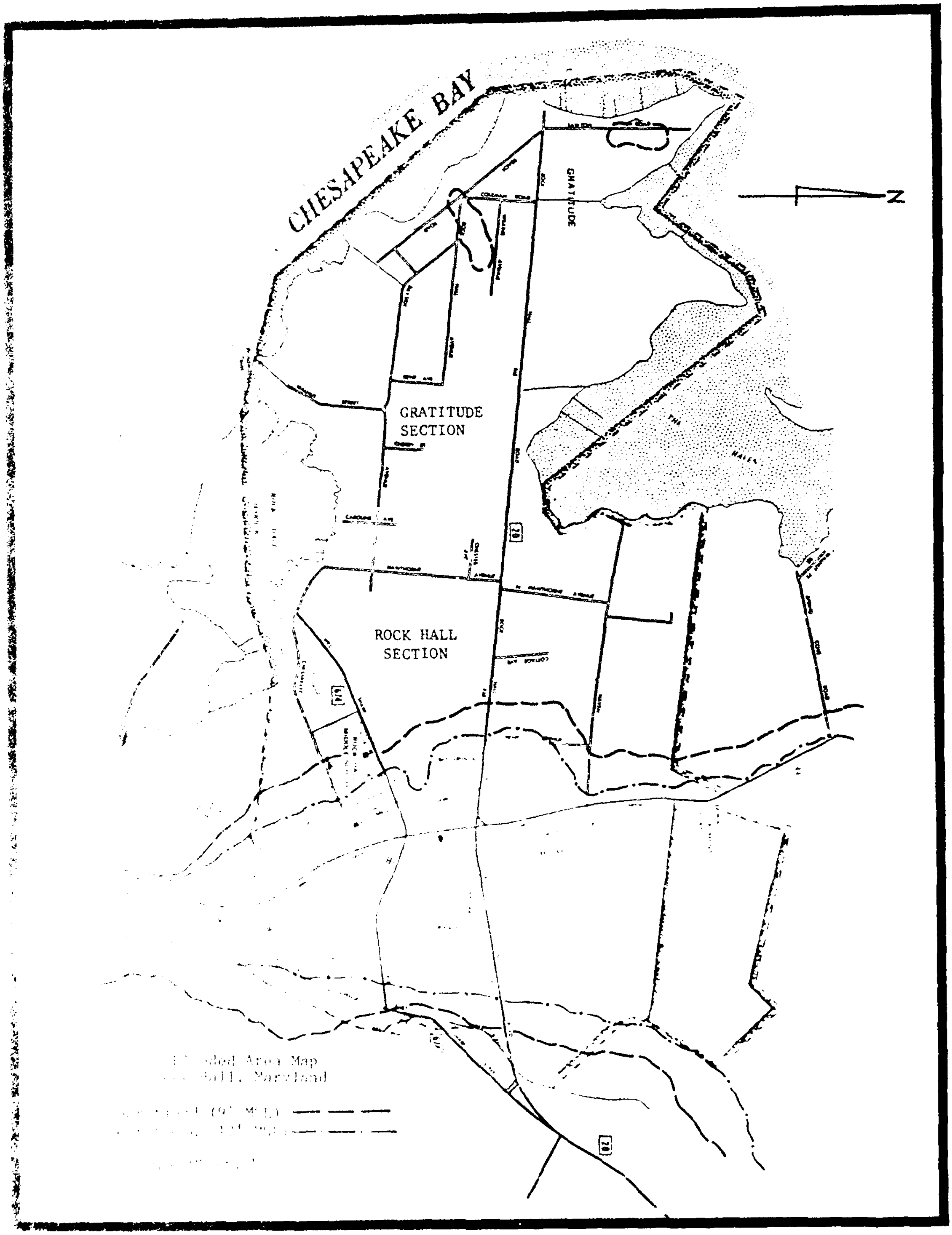
SNOW HILL, MARYLAND

Snow Hill is located on the Pocomoke River approximately 25 miles upstream from the River's entrance into Pocomoke Sound. Similar to Pocomoke City which is located approximately 13 miles downstream, Snow Hill is subject to tidal flooding produced by storm surges which have been translated up the Pocomoke River. Elevations within the community range from zero NGVD to approximately 25 feet NGVD with the lowest areas located along the river between Washington Street (Maryland Route 12) and Byrd Park.

The area inundated by the 100 and 500-year tidal floods is shown in Figure A-27. Based on a cursory inspection of the fluvial flood potential it appears that fluvial flooding would not produce elevations approaching the elevations projected for tidal events. Therefore, fluvial events were not considered in the engineering and economic analyses conducted for Snow Hill.

Information on historical flooding in the community is extremely limited. Included in Table A-15 is a summary of various flood damage-related information for both the 100 and 500-year events. The average annual flood damages for the community were estimated to be approximately $11,400, in July 1979 dollars.

As noted earlier in the discussion of Pocomoke City, local officials were advised of the Tidal Flooding Study in June 1979. While supportive of the study, local officials did not appear to be overly concerned regarding the potential for flooding and provided no specific guidance as to the type or level of flood protection desired.



TIDAL FLOOD AREA

TABLE A-14

ROCK HALL, MARYLAND, FLOOD DAMAGE POTENTIAL

Percent Chance of Occurrence In Years	Elevation in Feet Above NGVD	Area Inundated in Acres			Number of Structures Flooded				Total Damages ($1,000) (July 1979)
		Developed	Undeveloped	Total	Residential	Commercial	Other[1]	Total	
100	8.7	270	200	470	317	22	7	346	1,850
500	11.5	330	200	530	423	24	8	455	4,200

[1] Includes both industrial and public structures.

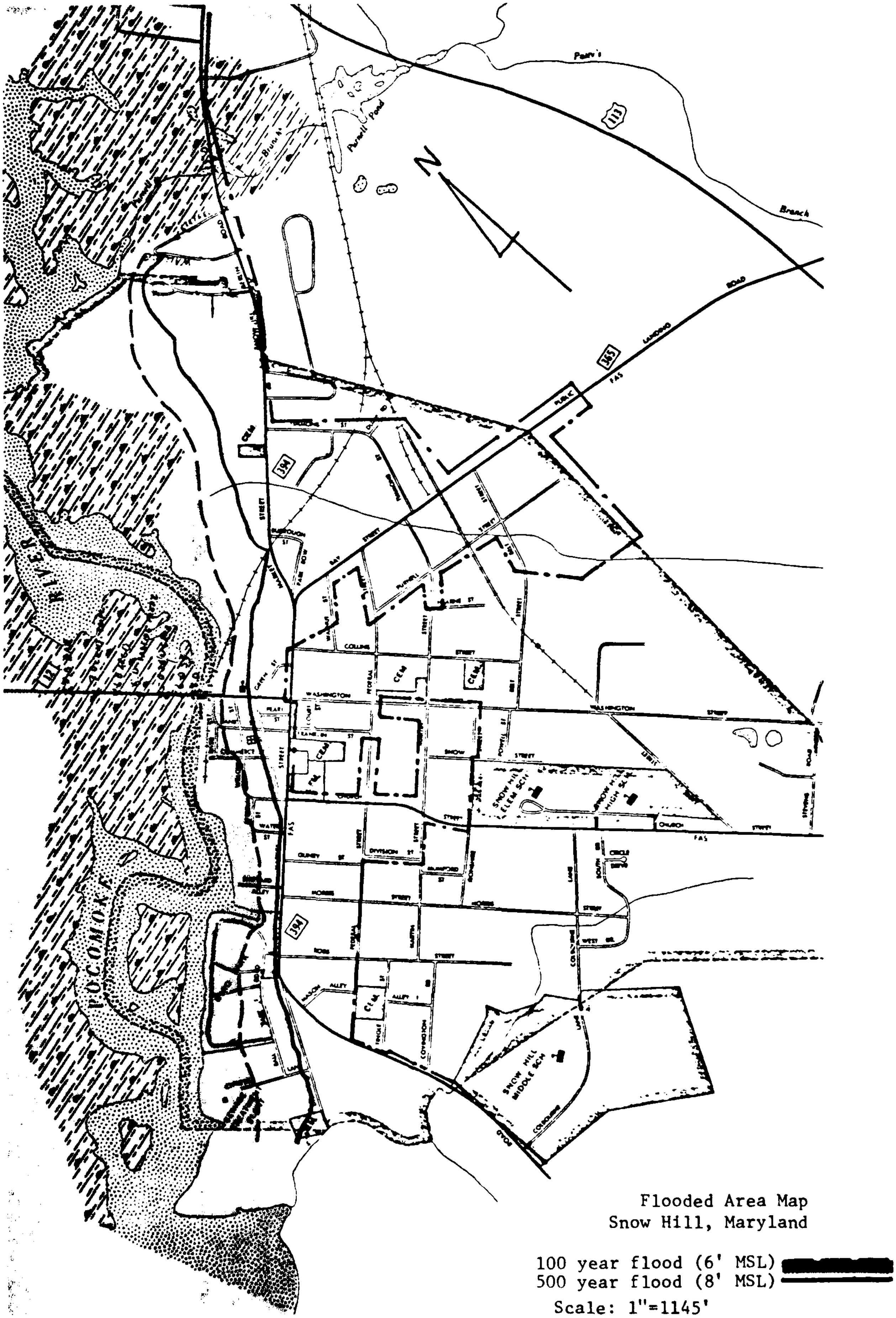


FIGURE A-27 SNOW HILL TIDAL FLOOD AREA

TABLE A-15

SNOW HILL, MARYLAND, FLOOD DAMAGE POTENTIAL

Percent Chance of Occurrence In Years	Elevation in Feet Above NGVD	Area Inundated in Acres			Number of Structures Flooded				Total Damages ($1,000) (July 1979)
		Developed	Undeveloped	Total	Residential	Commercial	Other[1]	Total	
100	6.3	20	70	90	13	14	1	28	200
500	7.8	40	100	140	62	22	4	88	600

[1] Includes both industrial and public structures.

AD-A161 477 CHESAPEAKE BAY TIDAL FLOODING STUDY APPENDIX A PROBLEM IDENTIFICATION APP..(U) CORPS OF ENGINEERS BALTIMORE MD BALTIMORE DISTRICT SEP 84 CHB-84-T-APP-A-B-C 2/4

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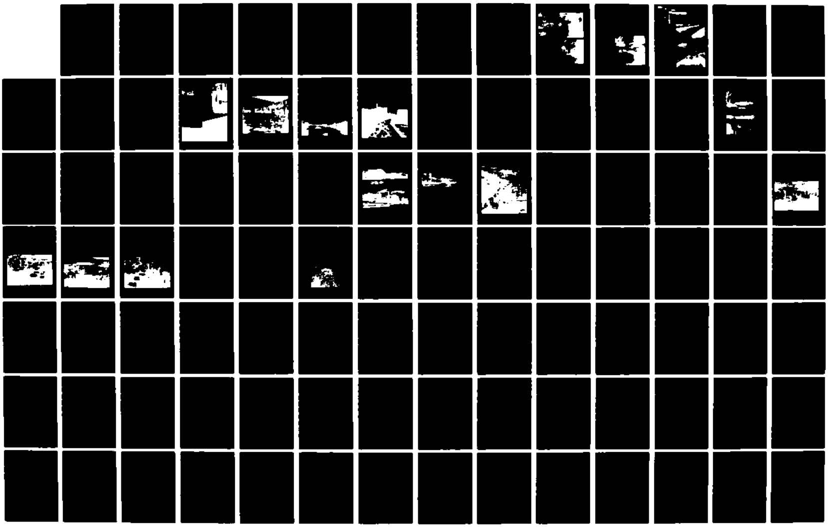
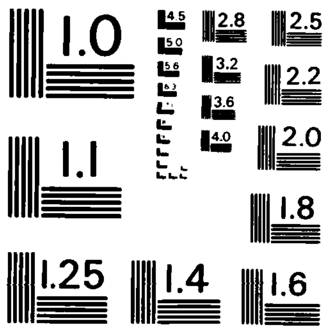




MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

ST. MICHAELS, MARYLAND

St. Michaels is located on the Miles River in the eastern part of Talbot County. With elevations ranging from zero NGVD to 15 feet NGVD the community is subject to tidal flooding. As shown in Figure A-28, which includes a delineation of the 100 and 500-year floods, the lowest portions of the community are adjacent to the harbor in the vicinity of Mill and North Harbor Streets. It should be noted that the western portion of town can receive flooding from tides that are forced up Broad Creek.

A recurrence of the flood of record (August 1933) is estimated to be a 100-year event and would flood approximately 70 structures and cause an estimated $150,000 in damages (July 1979 price levels). Table A-16 includes additional information relative to the flood damage potential in the community. The average annual flood damages for the without condition were estimated to be approximately $26,300 in July 1979 dollars.

In April 1979, meetings were held with the Talbot County Commissioners and local officials from St. Michaels. Local officials supported the study; however, the principal topic of discussion was the Flood Insurance Program and whether stage-frequency information from the Corps Study would be used to update the HUD study.

TILGHMAN ISLAND, MARYLAND

As an island located off the southwestern tip of Talbot County, Tilghman is particularly prone to tidal flooding. With a maximum elevation of only 10 feet NGVD, the entire island is subject to flooding with the exception of the high ground along Maryland Route 33 in the vicinity of Tilghman and Avalon. The area flooded by the 100 and 500-year floods is shown in Figure A-29.

The August 1933 flood is the flood of record and is estimated to be a 100-year event. A recurrence of that flood would cause an estimated $650,000 (July 1979 price levels) in damages and flood approximately 180 structures. Table A-17 provides additional data relative to the 100 and 500-year floods. The average annual damages for the without condition were estimated to be $34,700 in July 1979 dollars. The comments of local officials were outlined in the previous discussion of St. Michaels.

CAPE CHARLES, VIRGINIA

ALTERNATIVE FUTURE CONDITIONS

The most significant unknown factor in Cape Charles and Northampton County's future is what, if any, development will occur on a 980-acre parcel of land belonging to Brown and Root Company which was rezoned from agricultural to industrial use to enable the company to provide support to offshore oil development. This activity has not materialized. Whatever use is ultimately made of this land may significantly affect the County because of the probable size of any new activity relative to existing industries and infrastructure.

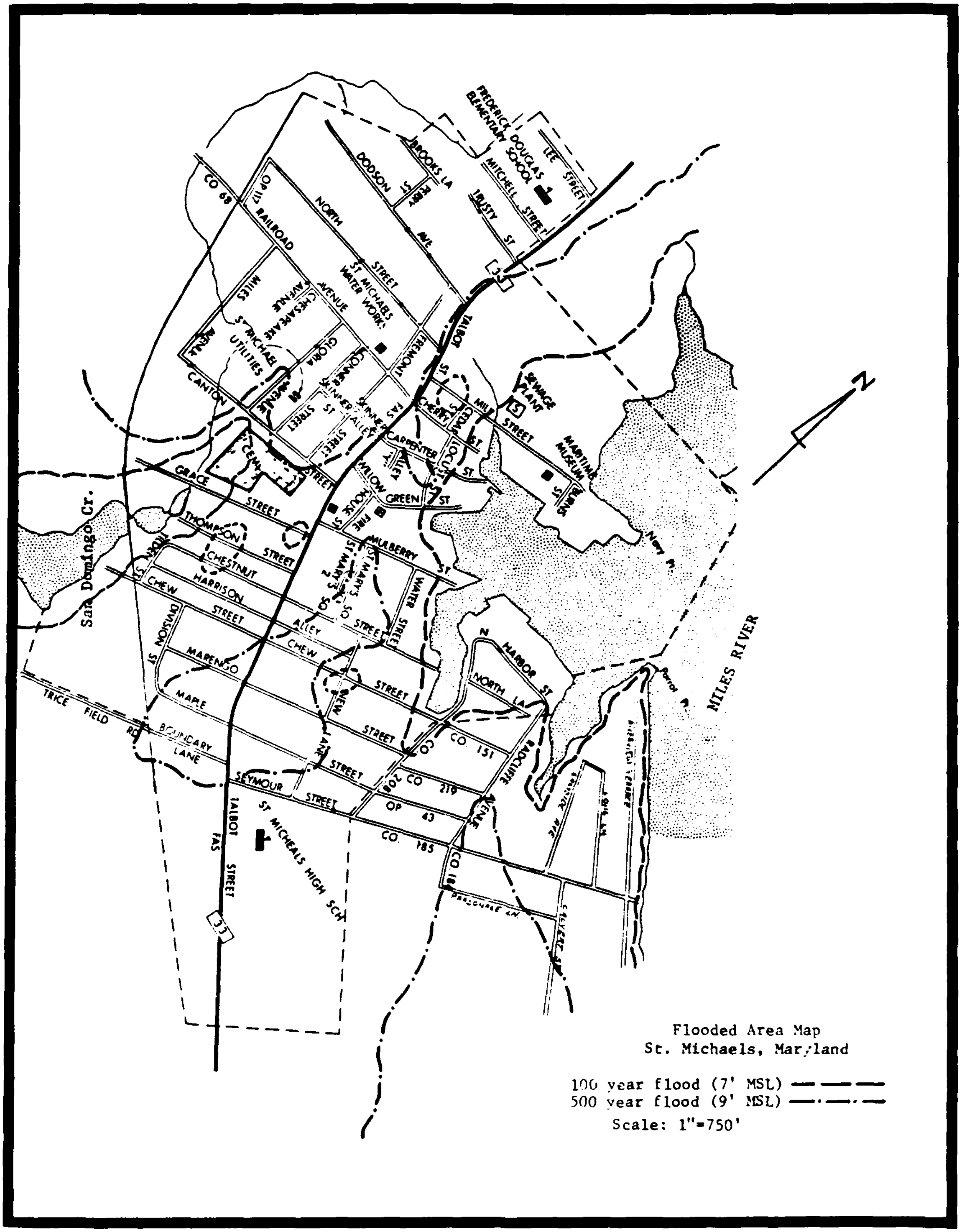


FIGURE 28 ST. MICHAELS TIDAL FLOOD AREA

TABLE A-16

ST. MICHAELS, MARYLAND, FLOOD DAMAGE POTENTIAL

Percent Chance of Occurrence In Years	Elevation in Feet Above NGVD	Area Inundated in Acres			Number of Structures Flooded				Total Damages ($1,000) (July 1979)
		Developed	Undeveloped	Total	Residential	Commercial	Other[1]	Total	
100	7.2	70	--	70	55	5	7	67	150
500	9.2	220	70	290	255	49	11	315	1,900

[1] Includes both industrial and public structures.

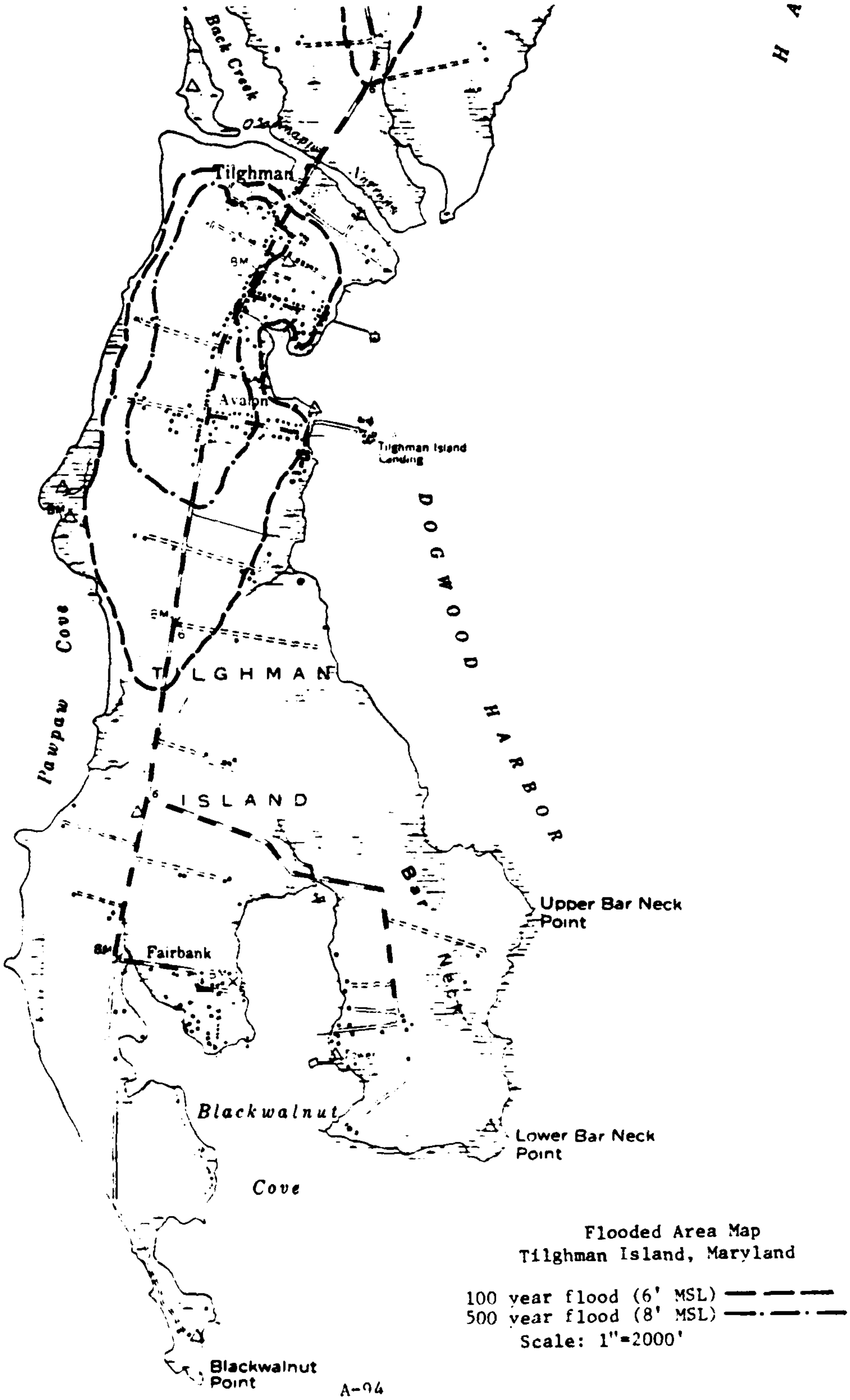


FIGURE A-29 TILGHMAN ISLAND TIDAL FLOOD AREA

TABLE A-17

TILGHMAN ISLAND, MARYLAND, FLOOD DAMAGE POTENTIAL

Percent Chance of Occurrence In Years	Elevation in Feet Above NGVD	Area Inundated in Acres			Number of Structures Flooded				Total Damages ($1,000) (July 1979)
		Developed	Undeveloped	Total	Residential	Commercial	Other[1]	Total	
100	6.1	240	870	1110	167	11	4	182	650
500	7.9	360	1040	1400	275	13	5	293	1,750

[1] Includes both industrial and public structures.

In the absence of some major stimuli, population and employment will probably follow established trends. Agriculture, food processing, and possibly fisheries employment will decline as these industries continue to replace labor with capital. In the case of fisheries, such as surf clams, regulatory programs designed to maintain maximum sustainable yields over the long run also tend to limit or reduce employment. In short, none of the trends appear to foreshadow a reversal of prior declines. Services and government employment can only offset other sectors somewhat. If gasoline price increases or a recession force a curtailment of recreational visits to the lower eastern shore, retail sales and employment related to the travel/tourist industry may also suffer.

VIEWS AND DESIRES OF LOCAL INTERESTS

According to the Mayor in 1980, the major desire of local interests was that the existing bulkhead which faces Chesapeake Bay be improved, outlet drainage lines repaired, and the overall condition of the structure and sand base be upgraded so that this project can still act as a positive deterrent to tidal flood stages and wave action, both with accompanying erosion, that develops in Chesapeake Bay opposite the town. Many of these concerns have been addressed by the recent improvements to the bulkhead undertaken by the Soil Conservation Service (SCS). Now that the SCS has completed its improvements to the bulkhead, the major desire of local interests is that the town's extensive network of storm and sewage lines be similarly rehabilitated.

RESOURCE MANAGEMENT PROBLEMS

Cape Charles lies on the Atlantic Coastal Plain and its topography consists of flat slopes and low elevations, as shown in Figure A-10. Most of the ground is below elevation 8 feet (100-year flood) and much of the remaining area is below elevation 12 feet (standard project flood). Despite the fact the adjacent land is higher and more suitable for development, the town is typical of most coastal communities whose dependence is on the sea. As a result, practically all of the existing development has taken place on the low ground near the water's edge. Figure A-10 indicates that much of the ground in Cape Charles would be inundated by the 100-year stage stillwater level. Wave action would raise the stage by about 4 feet.

The greatest tidal flood known in Norfolk Harbor was the result of a hurricane in August 1933. The maximum storm surge occurred about three hours before but persisted through the peak of the astronomical tide. The water level reached a maximum elevation of 7.0 feet in the Town of Cape Charles. The tidal surge created by the northeaster of May 1962 reached an elevation of 7.2 feet.

Historical accounts of both severe hurricanes and northeasters in the Norfolk-Hampton area date back several hundred years. Table A-18 lists the 10 highest tides recorded at Hampton Roads with corresponding elevations, where available, at other locations in the general vicinity of Cape Charles.

TABLE A-18

TIDAL FLOOD ELEVATIONS - HAMPTON ROADS

DATE OF FLOOD	MAXIMUM ELEVATION, FEET, MSL				
	HAMPTON ROADS[1] FROM 1927-date	NORFOLK HARBOR[2] FROM 1908-date		CAPE CHARLES FROM 1947-1952	KIPTOPEKE FROM 1951-date
			(3)		
August 23, 1933	7.5	8.0	8.05	7.0[4]	-
March 7, 1962	6.7	7.4	7.06	7.2[4]	6.4
September 18, 1936	6.2	7.5	7.55	6.4[4]	-
April 11, 1956	5.8	6.5	6.34	-	-
September 16, 1933	5.6	6.3	6.34	-	-
September 12, 1960	5.5	6.3	6.09	-	4.1
September 27, 1956	5.4	5.9	5.74	-	4.2
October 6, 1957	5.1	5.8	5.53	-	5.0
October 5, 1948	4.9	5.4	5.35	4.5	-
September 18, 1928	4.8	5.8	5.85	-	-

[1] Ten highest tides at Hampton Roads are listed (Sewells Point gage).
[2] U.S. Naval Shipyard, Portsmouth, VA.
[3] Maximum elevation feet, National Geodetic Vertical Datum, taking into account sea level and leveling accomplished by United States Geologic Survey.
[4] Estimated from high water data.

In 1935, the town constructed 2,400 feet of wood bulkhead along the Chesapeake Bay shorefront with Work Projects Administration (WPA) help (Figure A-12). This bulkhead, with top elevation of about 8.0, provides some protection and is effective in reducing damage from wave attack and shore erosion. During large and unusually severe storms, flooding may occur on the land side of the bulkhead as a result of waves overtopping the wall in combination with backup through several storm sewers which penetrate the wall. The north and south sides of the town are unprotected with the ground generally one foot or more below elevation eight. Damaging floods in September 1936, September 1960, and March 1962 occurred as a result of this overtopping and backup. Figures A-30 and A-31 show flood scenes in the town. The prolonged storm of March 1962 caused extensive damage to the bulkhead and severely eroded the sand beach fronting the wall. Following this storm, emergency restoration work was accomplished by the Corps of Engineers under the provision of Public Law 875, Eighty-first Congress. Figure A-32 shows views of the bulkhead, promenade, and beach areas as they looked immediately after the March 1962 storm and also as they appeared after restoration was completed. The U.S. Soil Conservation Service has recently completed its own improvements to the bulkhead.

The storm tides have penetrated several blocks into the developed sections of the town on a number of occasions. However, the damage has been light, primarily because most of the buildings on the flood plain have their first floors located 1 to 2 feet above ground level.

FIGURE A-30 CAPE CHARLES [illegible] SCENES, SEPTEMBER 1936 HURRICANE

FIGURE A-31 CAPE CHARLES FLOOD SCENE, SEPTEMBER 1960 HURRICANE

10b

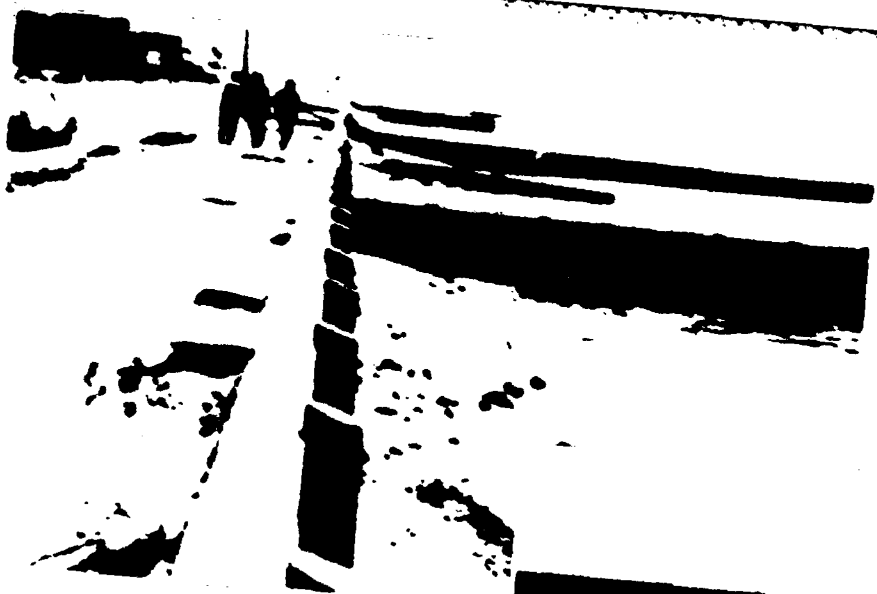


FIGURE A-32 BEACH, BULKHEAD, AND PROMENADE AT CAPE CHARLES FOLLOWING MARCH 1962 STORM

While buildings have generally been constructed to the level of the 100-year tidal flood stage, portions of the town including some existing streets, homes, and other improvements are dependent to a degree on the permanence of the bulkhead to provide a measure of protection against a moderate storm surge plus wave action and runup. Furthermore the road on the land side of the bulkhead is dependent on its existence in order to avoid erosion.

HAMPTON ROADS, VIRGINIA

ALTERNATIVE FUTURE CONDITIONS

The study area and its economy is heavily dependent on the Government and wholesale and retail trade as shown in Table A-19. A further discussion of employment in the study area is presented in Appendix D - Social and Cultural Resources.

TABLE A-19

OBERS COUNTY LEVEL EMPLOYMENT
BY SECTOR FOR THE FIVE-CITY
AREA (1978)

SECTOR	PERCENT
Total Government (incl. military)	40.6
Wholesale and Retail Trade*	18.4
Services	18.0
Total Manufacturing	6.3
Contract Construction	5.9
Percent of Total Employment	89.2

*Does not include wholesale trade for Chesapeake and Portsmouth.

The ports of Hampton Roads and the services and activities associated with them have a profound influence on the area's economy. Hampton Roads is the leader in export tonnage and second only to the port of New York in export-import tonnage in the United States. The value of these exports increased from $1.8 billion in 1970 to $8.85 billion in 1981.

According to a 1980 study by Drs. Jonathan Silberman and Gilbert Yochun of Old Dominion University, there were 134,693 jobs in 1979 within the Commonwealth of Virginia related to the movement of waterborne commerce through the ports of Hampton Roads. Employees who had port-related jobs earned salaries equal to roughly 10 percent of salaries and wages paid in the State of Virginia. Within Hampton Roads, 50,000 jobs, $1 billion of payroll, and $120 million in state and local taxes are attributable to port activity. Roughly 26,000 people are employed in the shipbuilding and repair industry alone, which receives a large percentage of its work from Navy contracts.

Historical unemployment rates in the study area have remained below U.S. levels. In 1982, the rate was 6.6 percent for the Norfolk-Virginia Beach-Portsmouth SMSA and 7.2 percent for the Newport News-Hampton SMSA.

The greatest increases in population are anticipated for Chesapeake and Virginia Beach. Based on census data for 1970 and 1980, Chesapeake grew by 27.8 percent and Virginia Beach grew by 52.3 percent. By comparison, Hampton grew by only 1.5 percent while Norfolk and Portsmouth both lost residents. The Virginia Department of Planning and Budget expects the study area to grow by 44.7 percent from 1980-2030 while Chesapeake and Virginia Beach are expected to grow 81.3 percent and 122.7 percent, respectively, during the same period.

Employment within the study area is related to the major economic activities of the two SMSA's. These will continue to be port, military/Federal government, and manufacturing operations. Also the services industry is expected to experience the most amount of growth in the period 1980 to 2030.

VIEWS AND DESIRES OF LOCAL INTERESTS

Norfolk has evidenced at public hearings great interest in resolving the flood and erosion problem along its entire shoreline fronting on Chesapeake Bay. It has stated that it would cooperate in a project that would reduce tidal flood damages and stem erosion. In addition, there is a general desire to increase the recreational potential within this area with specific emphasis on those conditions that affect beach erosion. Furthermore, Norfolk contributed to the cost of the Federally constructed floodwall for the reduction of tidal flood damages in the downtown area. Portsmouth, on its own, constructed a floodwall to protect its downtown business area from flooding.

Newport News and Chesapeake requested that the District Engineer study the tidal flood problem on streams in their cities. Newport News cooperated with the Corps of Engineers in a project involving the diversion of a stream to the tidal portion of the James River thereby reducing the fluvial flood problem along the stream. Both Newport News and Hampton cooperated in a shore protection project in their respective cities. All cities in the Hampton Roads area are cooperating in the Federal flood insurance program.

RESOURCE MANAGEMENT PROBLEMS

Norfolk

The City of Norfolk is located on the south shore of Hampton Roads and Chesapeake Bay. The city is bounded by water on three sides and is penetrated by smaller estuaries making interior areas vulnerable to tidal flooding.

Family dwellings are the largest single land use in the city and they occupy over one-third of the available land. The next largest use of land is by the Federal government with its military bases and other government functions.

Records of tide heights in the area have been maintained at the U.S. Naval Shipyard in Portsmouth since 1908. Other records at Sewells Point and Fort Norfolk in Norfolk,

Virginia, have been maintained for a lesser period. Historical accounts of floods prior to 1908 provide reasonably accurate knowledge of the flood situation for the past 200 years or more. Table A-20 lists the 10 highest tides recorded at Sewells Point and Norfolk Harbor.

TABLE A-20

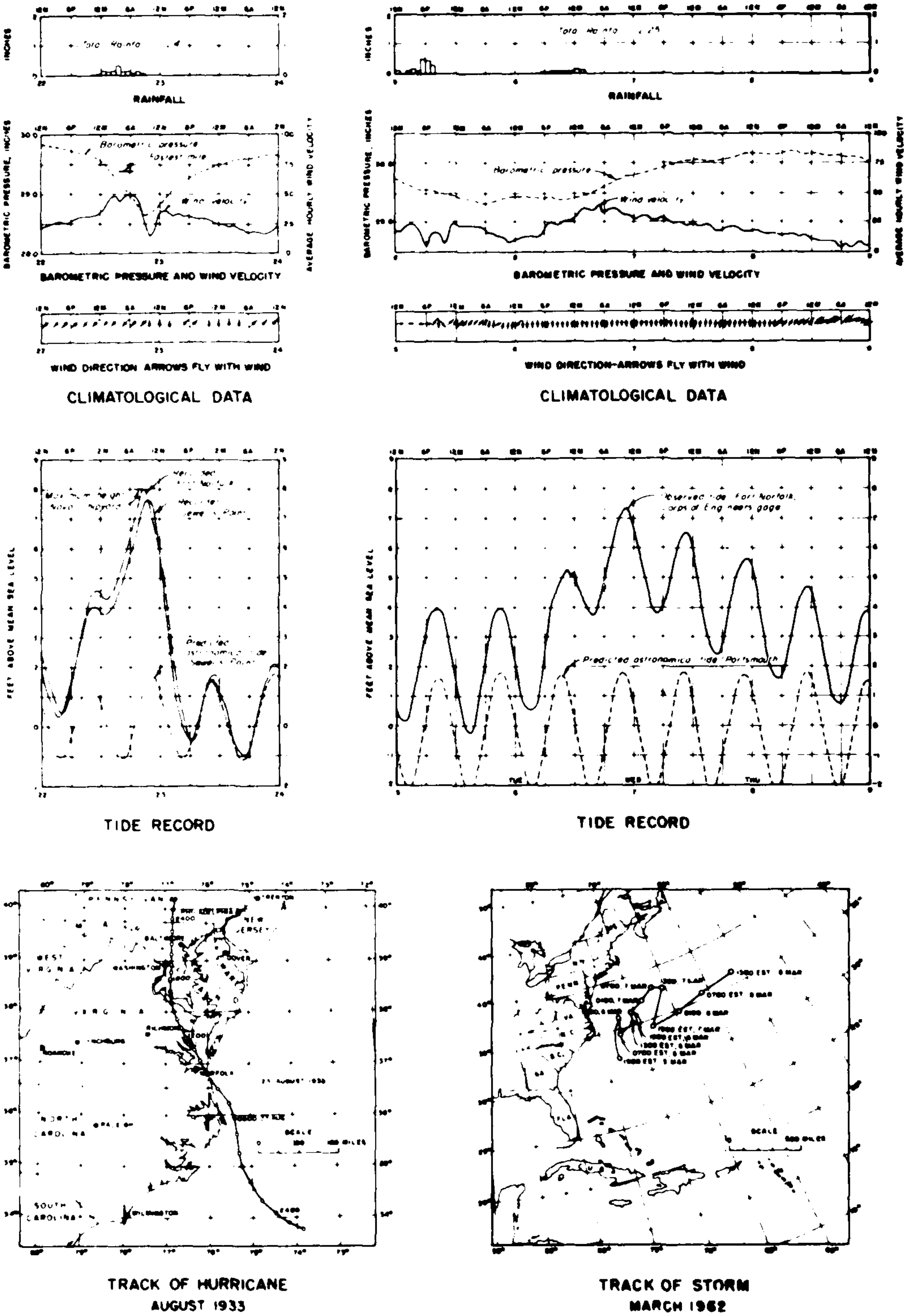
HIGHEST TIDES AT NORFOLK HARBOR AND SEWELLS POINT
(in feet)

DATE	NORFOLK HARBOR[1] 1908 - 1970[2] msl	NGVD[3]	SEWELLS POINT 1927 - 1970 msl
August 23, 1933	8.0	8.05	7.5
March 7, 1962	7.4	7.06	6.7
September 18, 1936	7.5	7.55	6.2
April 11, 1956	6.5	6.34	5.8
September 16, 1933	6.3	6.35	5.6
September 12, 1960	6.3	6.09	5.5
September 27, 1956	5.9	5.74	5.4
October 6, 1957	5.8	5.53	5.1
October 5, 1948	5.4	5.35	4.9
September 18, 1928	5.8	5.85	4.8

[1]Ten highest tides recorded at Sewells Point are listed.
[2]U.S. Naval Shipyard, Portsmouth, Va.
[3]Maximum elevation feet, National Geodetic Vertical Datum, taking into account sea level and leveling accomplished by United States Geologic Survey.

Figure A-33 shows the tide hydrographs of flooding in Norfolk Harbor and Hampton Roads which occurred as a result of the 1933 hurricane and the March 1962 northeaster. These hydrographs are typical of the duration of flooding and the rate of rise of water levels for each of these types of occurrences. They indicate for example that the 1933 hurricane exceeded elevation 5 feet for 9 hours, whereas the 1962 northeaster exceeded elevation 5 intermittently for almost two days.

Approximately 75 percent of the land in Norfolk is below elevation 13 (the Standard Project Flood) and 20 percent is below elevation 9. Generally, the terrain slopes fairly uniformly from the higher elevations to about zero NGVD. Fluctuations in water levels from approximately 1.4 feet below to 1.4 feet above NGVD occur twice daily as a result of the normal astronomical tide. Minor flooding up to elevations of 4 to 5 feet is associated with periods of moderately high sustained winds from the northeast, north, and northwest and may be experienced several times within any one year. Flooding of this magnitude is not serious and goes unnoticed except for the temporary difficulties



HAMPTON ROADS, VA.

METEOROLOGIC AND HYDROLOGIC DATA

STORMS of AUGUST 1933 and MARCH 1962

February 1968

FIGURE A-33 METEOROLOGIC AND HYDROLOGIC DATA, STORMS OF AUGUST 1933 AND MARCH 1962

which may be experienced by the boating interests due to rough seas. The main source of concern is the large and infrequent floods which are associated with major storm events such as hurricanes or severe northeast storms. Storm surges, which together with the normal astronomical tide produce elevations of 6 feet or higher, cause widespread flooding in the city. Figures A-34, A-35, and A-36 are typical scenes in the city during major storm surges.

Wave action has been responsible for most of the structural damage along the shore front. The shoreline of Norfolk is exposed to wave attack from the north, west, and southwest. The Federal Emergency Management Agency has published new flood insurance rate maps which take into account the effect of wave action. Wave heights to be expected with the 100-year flood range from elevation 13 in the Willoughby area to elevations 9 and 10 along the Elizabeth River. This new information should be considered in a detailed study to evaluate the impact on the economic feasibility of possible tidal flood protection measures.

The disastrous hurricane of 23 August 1933 inundated about 600 acres in the downtown Norfolk area. The greatest concentration of damage occurred in the Central Business District where 52 acres, containing streets, stores, and business offices were flooded from 1 to 4.5 feet by salt water polluted by industrial and sanitary wastes. High water blocked practically all movement to and from the Central Business District. Other sections of the downtown area flooded included 150 acres in the Hague area, 140 acres in the Tidewater Drive area, and 72 acres in the waterfront area.

The exposed beach resorts of Willoughby and Ocean View felt the full fury of the storm. Of 146 cottages in Willoughby, only 5 escaped unharmed. Some 200 people were rescued from their homes. One person was drowned. According to the Weather Bureau report (now the National Weather Service), the total damage, undoubtedly including wind damage, was $2,285,000.

During the March 1962 northeaster, more than 1,000 persons were evacuated from the area along Chesapeake Bay and a few were evacuated from other areas. The flow of automobile traffic was impeded by the flooding of streets, including access roads to tunnels. Table A-21 shows the damage caused by the March 1962 northeaster. Damages totaled about $5 million including almost $2 million in the Norfolk downtown area.

There are large areas in Norfolk that have the potential for flooding by the 100-year flood. They include:

a. Willoughby
b. Edgewater and Larchmont
c. Belvedere and Riverpoint
d. Hague
e. Tidewater Drive.

The Central Business District has been protected by a floodwall to a level one foot above the 100-year elevation. The floodwall is shown in Figure A-37.

FIGURE A-34 FLOOD SCENES, MARCH 1962 "NORTHEASTER" AT NORFOLK, VIRGINIA

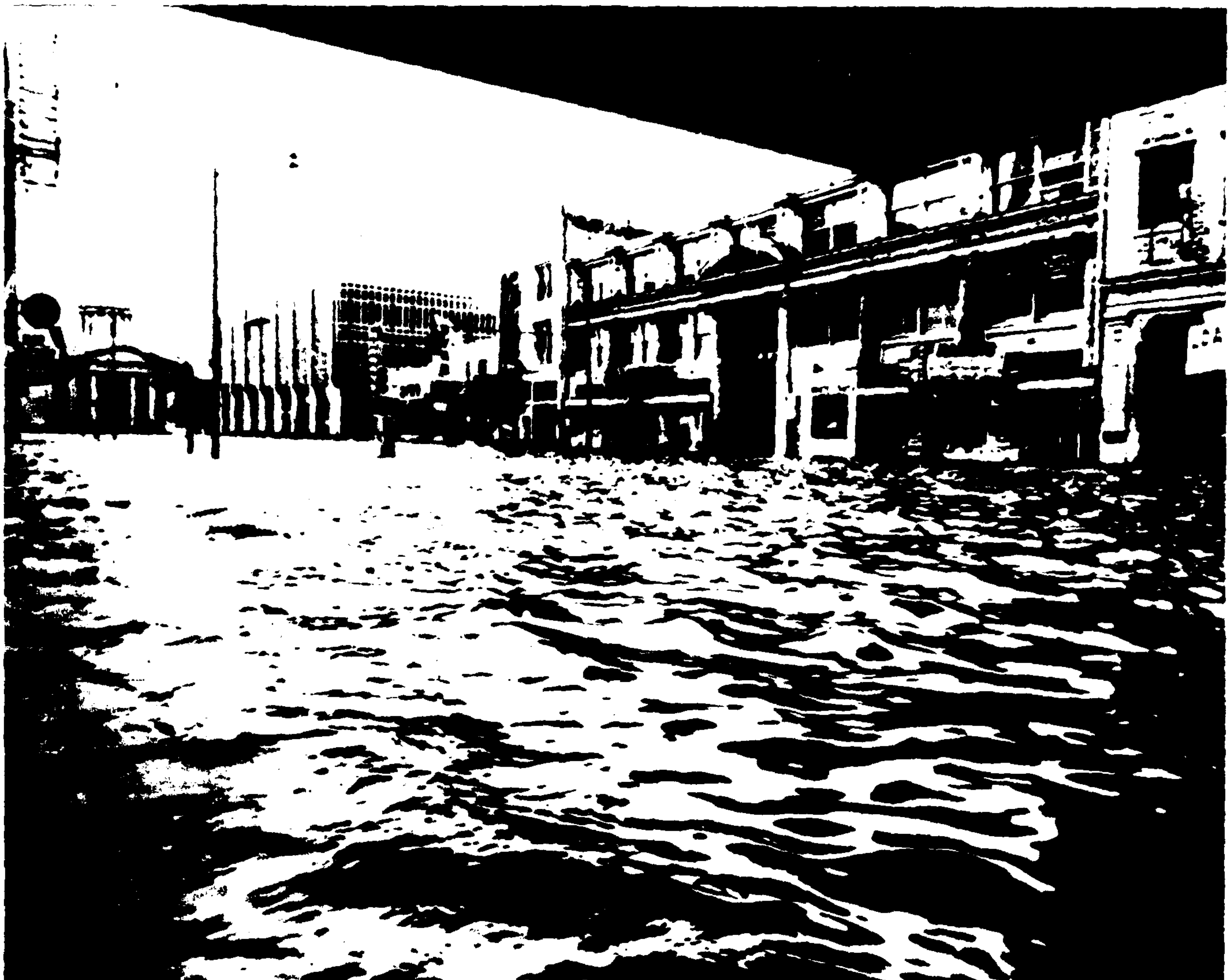


FIGURE A-35 FLOOD SCENE, MARCH 1962 "NORTHEASTER" AT NORFOLK, VIRGINIA

FIGURE A-36 FLOOD SCENE, MARCH 1962 "NORTHEASTER" AT NORFOLK, VIRGINIA

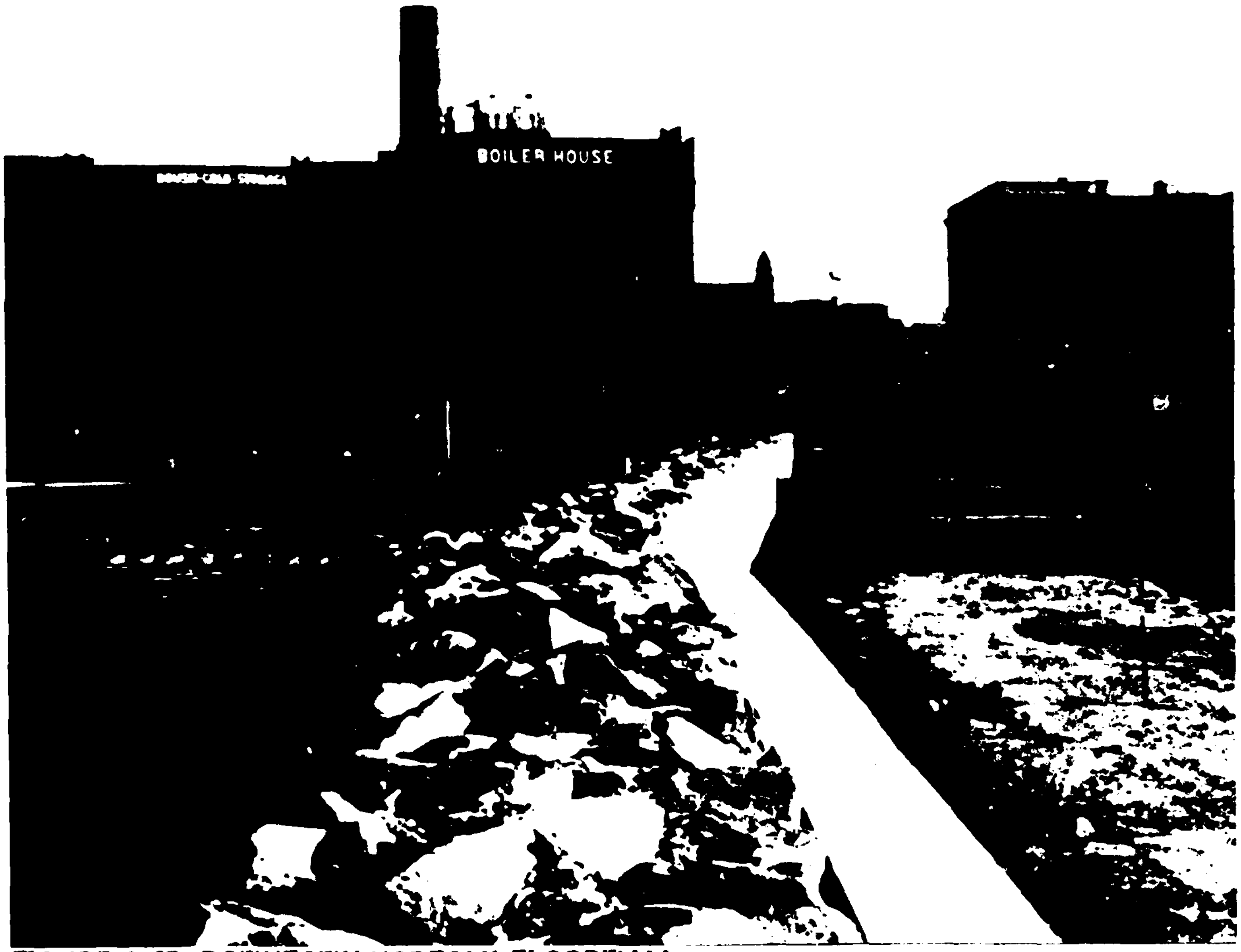


FIGURE A-37 DOWNTOWN NORFOLK FLOODWALL

TABLE A-21

DAMAGES FROM MARCH 1962 NORTHEASTER IN NORFOLK

LOCATION	DAMAGE
Chesapeake Bay Willoughby	Due principally to flooding from Bay. 460 residences, 5 commercial buildings, 1 boat, and 250 automobiles were damaged.
East Ocean View	Due principally to flooding from Little Creek. 661 residences, 1 church, 70 commercial buildings, and 200 automobiles were damaged.
Elizabeth River	
Downtown Norfolk	Water entered over 100 commercial buildings.
Hague area	2 residences, commercial and public buildings.
Lafayette River Larchmont	Extensive damage to many heating systems in basements and/or garages.
Colonial Place	Number of houses, Lafayette Yacht Club, streets, and basements flooded.
Above Granby St. Bridge	Confined to lawns and shrubs.

Willoughby

The northern shoreline of the city, bordering on Chesapeake Bay and commonly known as Ocean View-Willoughby, is predominantly residential-resort, with commercial and public uses interspersed. The housing there is extremely varied, with structures of all types and price ranges found. Along the Bay front itself, many of the houses are frame buildings on long narrow lots (25-foot widths are common in East Ocean View). Some of the housing, especially in East Ocean View, is dilapidated, while in the same area, small, more substantial apartment complexes built in the late 1960's and early 1970's also exist. There has been some housing construction in recent years, particularly as the older, rundown structures are torn down and replaced with primarily multifamily housing of various types. This new construction and stricter enforcement of the minimum housing code have helped to raise property values in the past few years significantly more than in previous years.

Because of its exposed location on the Bay, the entire area is readily susceptible to damages arising from the occasional hurricane or northeaster. Extensive inundation can be expected, along with a significant amount of wave action, which may result in damages to transportation routes, losses to non-fixed or transient items such as vehicles, and various types of indirect business and financial losses. At present there are no

unified structural plans addressed to reducing damages such as these, though several private property owners have undertaken the construction of individual bulkheads of timber, concrete, and stone.

The area must also contend with a serious beach erosion problem, which not only reduces the amount of beachfront property available for use, but allows those waves associated with storms to break even further onshore. Recent shoreline comparison studies indicate that, in general, the Willoughby Spit and Western Ocean View shoreline segments are continuing to erode at their historical rate of 2 feet per year or less, while along the East Ocean View segment, there appears to be a more recent trend toward increased recession, on the order of perhaps 6 to 10 feet per year. For the present, the only unified structural protection against such erosion is a system of 37 groins constructed by the City of Norfolk and found along Willoughby Spit and Western Ocean View.

In accordance with a Congressional resolution, a hurricane protection and beach erosion control study of the entire Willoughby vicinity was completed by the Norfolk District Corps of Engineers in January 1983, and is currently under review by higher authority. That report recommended construction of a protective berm along the entire 7.3-mile Chesapeake Bay shoreline of the City of Norfolk where an adequate berm does not already exist.

Edgewater, Larchmont, Belvedere and Riverpoint

The Elizabeth River and Southern Branch of the Elizabeth River on the western shoreline of Norfolk is occupied by U.S. Government installations and numerous shipping terminals. Residential development is limited to the sub-divisions of Edgewater and Lockhaven. The Lafayette River, a tidal estuary, penetrates eastward into the city and includes the Larchmont area. This estuary has a shoreline of approximately 44 miles and it is completely developed as residential sub-divisions. A field investigation was conducted in Edgewater, Larchmont, Belvedere, and Riverpoint to determine the extent of the flood problem and any evident solutions.

According to the report "Coastal Flooding in Norfolk, Virginia," published in March 1970 by the Norfolk District Corps of Engineers, there are about 600 acres in Edgewater and Larchmont and about 200 acres in Belvedere and Riverpoint that would be flooded by the 100-year storm.

Edgewater and Larchmont are middle-class neighborhoods that sustained damage in the 1962 storm. Most of the homes are well maintained with relatively high first floor elevations. No measures of protection were developed for this area and none would appear to be economically justified. Belevedere and Riverpoint consist of middle- and upper-class homes that are well maintained. They are at a relatively high first floor elevation. There would appear to be no economically justified protective measures which could be implemented in this area.

Hague and Tidewater Drive

Southern portions of the city border on the Eastern and Southern Branches of the Elizabeth River as shown in Figure A-13. Development near the mouth of these two tidal estuaries has been chiefly industrial or commercial. Further inland, along both sides of the Eastern Branch, the land is occupied almost entirely by residential subdivisions.

The Hague and the Tidewater Drive areas in this section of Norfolk were studied along with the central business district in a Norfolk District report dated 1 October 1959. They were studied to determine the possibility of developing an economically feasible plan of protection by the construction of floodwalls as a primary means of tidal flood control. The plans included pumping and drainage facilities necessary to prevent ponding in the areas to be protected from local runoff. Table A-22 summarizes pertinent economic data for protecting the following three areas to the most favorable elevation.

TABLE A-22

PROJECT AND ECONOMIC DATA FOR
LOCAL PROTECTION WORKS IN NORFOLK
(1959 DOLLARS)

ITEM	CENTRAL BUSINESS DISTRICT	HAGUE AREA	TIDEWATER DRIVE AREA
Protection provided:			
Stillwater level, msl	10	10	9
Area protected, acres	85	258	180
Protective works:			
Length of wall, ft.	2,750	3,950	3,300
Average height above ground level, ft.	7	5	5
No. closures	6	4	3
Size pumping station, GPM	100,000	155,000	72,000
Cost	$2,329,000	$2,508,000	$1,575,000*
Economic analysis:			
Annual charges	$115,000	$116,000	$85,000
Annual benefits	$178,000	$59,000	$3,000
Ratio of benefits to charges	1.5 to 1	0.5 to 1	0.04 to 1

*Includes cost of wall and pumping station only.

The above table indicates that local flood protection works were not economically feasible for either the Hague or Tidewater Drive areas at that time. The Central Business District was economically justified and a Federal project was authorized and constructed.

A field investigation of the Hague and Tidewater Drive areas was made to determine if sufficient development had taken place in these areas since 1959 to warrant further study. In the Hague, many sections that were to be protected have been redeveloped. The new homes appear to be at the 100-year flood elevation. Also in the vicinity of Hague are two commercial areas, a high rise apartment building, and the Chrysler Museum. These areas and the restored older homes in this vicinity appear to be at lower

elevations than the redeveloped areas. This development and renewed interest in the Hague area warrant that it be reinvestigated as to the economic justification of protective measures.

In the Tidewater Drive area, there are some old homes with low first floor elevations. It also includes redeveloped homes, an apartment complex, and a shopping center. This section also contains a portion of the business district with office buildings whose first floor appears to be high. A detailed investigation is not warranted due to the low economic feasibility in the 1959 report.

In Norfolk there are numerous other areas that will experience occasional flooding. These areas lie along rivers and creeks and are scattered throughout the city. There is no plan to eliminate this situation that would be economically feasible.

Since Norfolk is surrounded on three sides by water, continuous travel within the city without crossing a bridge or causeway is almost impossible. Many bridges and roads leading to them are low and are subject to inundation during large tidal floods. Thus, during these events, there is danger of large segments of the population becoming marooned because of the blocking of escape routes. For example, an alarm system has been installed in the midtown tunnel connecting Portsmouth and Norfolk which alerts appropriate tunnel commission personnel during times of abnormally high tide in the river. Although the tunnel is protected to elevation 9.5, it is understood that it would be closed to traffic and sealed whenever the river level reaches elevation 8 - the 1933 peak tidal stage, exclusive of wave action.

Portsmouth

Portsmouth is located near the confluence of the Western and Southern Branches of the Elizabeth River tidal estuary. Forming a part of the greater Hampton Roads Harbor, Portsmouth is a major port of call for oceangoing vessels. Norfolk Naval Shipyard, one of the largest facilities of its type, is located here. Portsmouth is part of Virginia's largest metropolitan center.

Typical of Virginia's coastal plain, the topography of Portsmouth is flat and featureless with land elevations seldom exceeding 15 feet above NGVD. While some developments on the flood plain are more susceptible to flood damage than others, experiences gained particularly in the March 1962 northeast storm and the August 1933 hurricane, have shown that the flood problem is serious and that damage can be widespread throughout the city. The August 1933 hurricane produced flooding to elevation 8 throughout most of the city.

Damage during smaller floods under elevation 5 is confined to streets together with the resulting traffic problems that are created. Also, there would be some minor flooding of other low-lying property. However, between elevations 5 and 10, there are large concentrations of commercial, residential, and industrial buildings. It is within this zone that serious flood damage has been suffered during past tidal floods and where the potential exists for even greater loss in future floods.

The amount and extent of damage caused by any tidal flood will depend upon the topography of the area flooded, rate of rise of floodwaters, depth and duration of flooding, exposure to wave action, and the extent to which damageable property has been

placed on the flood plain. Large residential, commercial, and industrial sections of Portsmouth would be inundated by the intermediate regional tidal flood (100-year flood, stillwater elevation 8.5). Much more area would be affected by the larger Standard Project Flood, elevation 13. While property damage during either of these events would be substantial, sometimes the most devastating effects of floods are those which do not involve the destruction of, or damage to, physical property. For example, no monetary value can be placed on human suffering, and even worse, possible loss of human life that sometimes occurs as a result of floods.

Fortunately, tidal flooding is usually characterized by a gradual increase in water levels which under normal conditions permit orderly and timely evacuation in the face of the encroaching floodwaters. In some cases, however, low-lying access roads connecting islands of higher ground with the safer mainland areas are inundated in the early stages of the flood. Unless this possibility is recognized and precautions taken accordingly, large segments of the populace may find themselves marooned during a large flood. A further danger lies in the possibility that higher flood levels occurring later during the storm may trap persons in homes that are ultimately destroyed or in vehicles that are ultimately submerged or floated. Water lines can be ruptured by deposits of debris and the force of floodwaters, thus creating the possibility of contaminated domestic water supplies. Damaged sanitary sewer lines and sewage treatment plants could result in the pollution of floodwaters creating health hazards. Isolation of areas by floodwater and by debris would create hazards in terms of medical, fire, or law enforcement emergencies. The above problems could apply to any of the cities in the Hampton Roads complex.

The city sustained a great deal of damage during the 1962 northeaster, primarily from flooding in several low areas bordering on the Elizabeth River and Southern Branch. Three hundred and twenty houses and 20 commercial and industrial businesses received damage in various degrees from flooding to a depth of water as much as 4.5 feet. One thousand automobiles were inundated. Federal, state, and local agencies were active during the emergency and in removing debris after the water subsided. Emergency operations consisted mainly in evacuating children and other personnel from the school at Fifth and Jefferson Streets. Also, many persons including entire families, were evacuated from their homes on First and Second Streets. A number of roads were rendered impassable for 2 days. Telephone and electric power services were disrupted. Along the Western Branch of Elizabeth River, much of the damage was sustained by boats and facilities. Several homes and businesses were flooded and one industry suffered additional loss from having to suspend operations for the duration of the storm. Damages totaled $1.5 million. Figure A-38 shows a typical scene during the March 1962 northeaster in Portsmouth. The August 1933 storm caused extensive damage, inundating hundreds of acres of the city including downtown commercial and industrial areas as well as residential areas. Figure A-39 shows the area inundated by the August 1933 hurricane in Portsmouth.

A plan which would furnish protection to the City of Portsmouth to elevation 8, excluding the naval shipyard, was considered by the Norfolk District in 1963. It would have required a partial ring wall approximately 24,000 feet long. A tidal lock to permit small shipping would have been required at Scott's Creek. Such a plan would have required 20 closures and 3 pumping stations. The cost of the plan was in excess of $15 million with annual charges of $700,000 and average annual benefits of less than $150,000. The economic ratio of benefits to costs was 0.2. Modification of this plan was

WAVERLY BOULEVARD BETWEEN COURT AND DINWIDDIE STREETS

CORNER OF WASHINGTON STREET AND CRAWFORD PARKWAY

FIGURE A-38 FLOOD SCENES, MARCH 1962
"NORTHEASTER" AT PORTSMOUTH, VIRGINIA

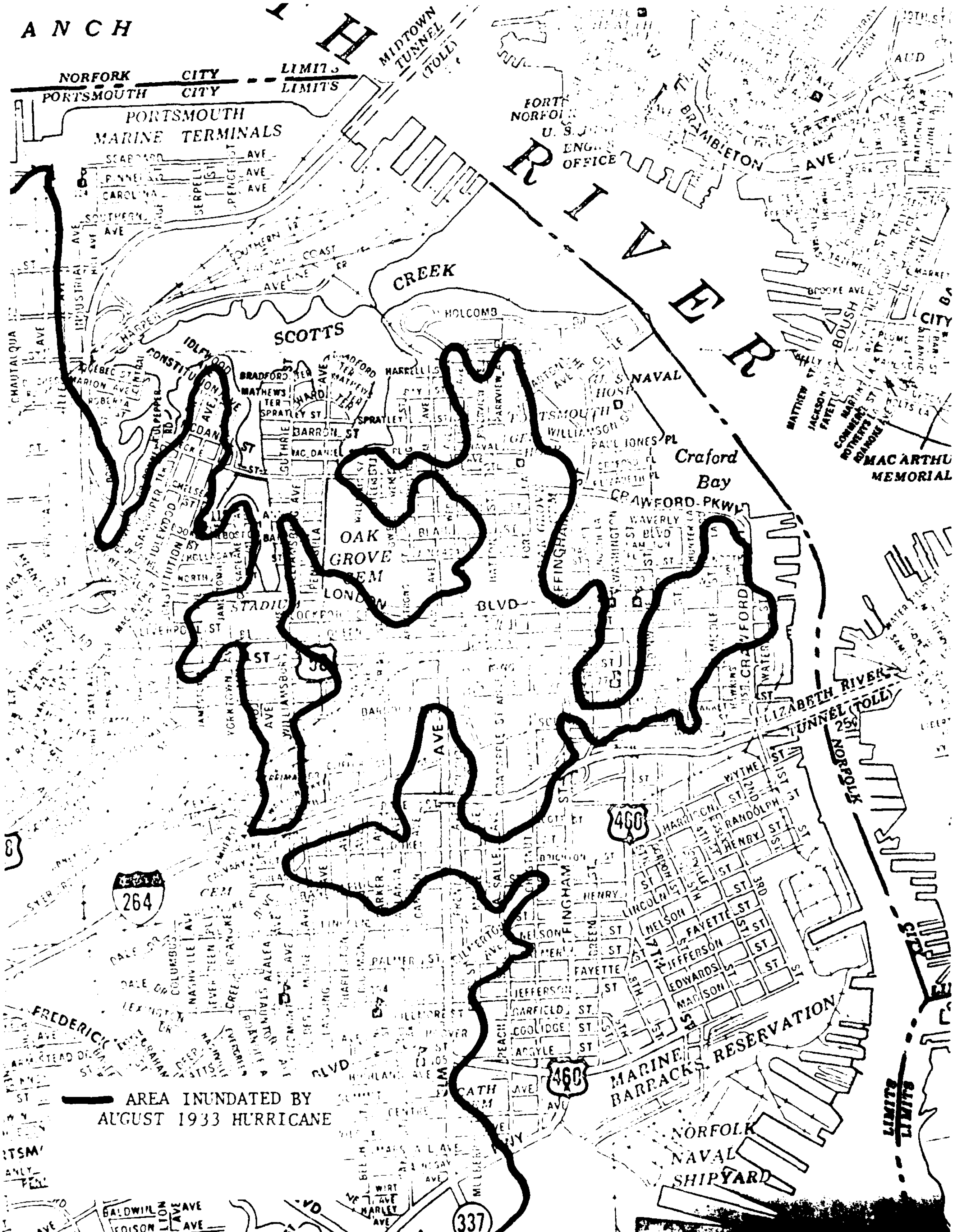


FIGURE A-39 PORTSMOUTH AREA INUNDATED BY AUGUST 1933 HURRICANE

made to eliminate the Scott's Creek area and make a tie-out at Glasgow and Godwin Streets. This modification would have increased the number of closures and made the scheme more cumbersome to operate with less area protected.

An alternate plan was prepared to protect just the Dinwiddie Street area. The steel sheet pile wall would have been 6,400 feet long and one storm water pumping station would have been required. One hundred acres would be protected against a tidal storm as high as that in August 1933. The cost would have approached $2.5 million, with the annual charges of $123,000, and average annual benefits of $5,000, providing for a benefit to cost ratio of 0.04. Thus protective works for the City of Portsmouth or portions thereof were not economically justified in 1963.

Since then, the City of Portsmouth has closed streets, raised roads, and constructed a floodwall that extends for a distance of 3,500 feet along the waterfront. A pedestrian promenade runs parallel to a substantial portion of the top of the wall. The elevation of the top of the floodwall and roads, as shown on a Corps of Engineers permit, varies from 8 to 8.5 NGVD. Other sections, for which permits were not required, show a top of wall elevation of 9 feet. The floodwall in Portsmouth does provide some protection in the downtown area. Surface drainage behind the protective works includes a number of openings through the wall which have been provided with flap gates. These are quite large and vary in size from 30 inches in diameter to 40 inches by 24 inches. During high river stages, these gates presumably will close and thereby prevent surface waters from escaping unless the interior water level rises to a height above the level of the tidal waters in Chesapeake Bay. However, there are questions as to whether the flap gates in the floodwall would perform as designed during a major tidal storm.

A field investigation was conducted in the area behind the shipyard and south of Interstate 264 which lies within the 100-year flood plain. A large portion of this section has been redeveloped with single-family homes which have been built at a fairly high elevation. The remaining area has been cleared and is awaiting development.

During discussions with the superintendent of surveys in Portsmouth, one problem area was discovered. It is landward of Crawford Bay where many homes have been restored. The concrete bulkhead here is below elevation 6. The city also has a problem with sand depositing in Crawford Bay which blocks the drainage outlets and must be dredged periodically.

In both Crawford Bay and downtown sections of the city, consideration of a pumping station is warranted, since water may not be able to recede rapidly from these areas under present conditions. The renewed development and interest in these areas warrants a study to determine the economic feasibility of protective measures.

In Portsmouth there are numerous areas that are prone to flood damage that lie mostly along creeks or rivers. There are no measures which can be utilized to economically protect these areas. The residents need to be advised of the dangers and they need to receive word of an impending storm as soon as possible since some of the roads along these homes are at low elevations.

Chesapeake

The topography of the City of Chesapeake is typical of the flat Tidewater coastal plain in which the city is located. Development consists generally of residences along the northern boundary. Thus, development is a continuation of the urban growth of the cities of Norfolk and Portsmouth. The municipal government civic center is located at Great Bridge. This area also contains a central commercial shopping and banking area. Other large commercial developments are located in the Churchland and South Norfolk areas. Interstate 64 is located in the northern portion of the city. Major industrial development exists along the Southern Branch of the Elizabeth River. The central and southern portion of the city is not affected by the Chesapeake Bay and its estuaries.

Flooding of that portion of the city affected by the level of water in Chesapeake Bay occurs as a result of high water in the Elizabeth River and its Southern and Western Branches. Storm surges, which together with the normal lunar tide produce a water level of elevation 5 or higher in the northern section of the city, cause widespread flooding and produce damage. Floods this high and higher have occurred many times in the past. Also most major roads and bridges would have areas wherein flooding will occur during both the intermediate regional tidal flood (100-year, elevation 8.5), and the standard project tidal flood (elevation 13).

The substantial number of hurricanes, tropical storms, and northeasters which have been experienced in and near the area in the past, serves as an indicator for the future. A year seldom passes without some type of storm activity sufficiently severe to cause flooding. Quite frequently, several storms with accompanying flooding occur within the same year. Studies indicate that 64 storms of hurricane force have passed within a 200-mile radius of the study area during an 81-year period, between 1886 and 1966. Of course, all of these hurricanes did not cause flooding. Many passed practically unnoticed because of the distance between their area of maximum winds and Chesapeake. Others coming nearer to the area caused little or no flooding because they were not on a path favorable to producing a significant storm surge or else they passed at the time of low or near low astronomical tide. Nevertheless, all hurricanes, because of their high wind speeds (75 miles per hour or greater), are a potential flood threat. It is, therefore, desirable to consider this factor in connection with any determination of future floods which may occur at Chesapeake or any of the other cities. For instance, a slight change in the forward speed and direction of some of the storm centers which have threatened the area in the past could have significantly affected the flood heights and wave action which were actually experienced.

High tides during the March 1962 storm entered into the Eastern and Southern Branches of Elizabeth River in Chesapeake. No mass evacuation of people was required. However, many were forced to abandon their homes and businesses to avoid the high water. Table A-23 is an indication of the damage sustained. The total damage in Chesapeake, as a result of tidal floodwaters flowing into Chesapeake Bay was estimated at $439,000.

A field reconnaissance was made of localities along the Southern Branch of the Elizabeth River that would be inundated by the 100-year tidal flood stage. The area along Bainbridge Boulevard consists of older homes and industrial developments along the river. The homes have a low first floor elevation as do some of the industrial complexes. Some homes are in poor condition and vacant. The area has been divided by the construction of Interstate 464.

TABLE A-23

DAMAGES FROM MARCH 1962 NORTHEASTER IN CHESAPEAKE

LOCATION	DAMAGE
Elizabeth River-Southern Branch Portlock Area	25 houses flooded 18 inches and an equal number had flooding to a lesser degree.
Crestwood	Entire Crestwood housing development flooded.
Along river	Shipyards, fertilizer plants, and construction companies experienced flooding.
Along US Hwy. 460	Small commercial shops experienced flooding. Four motor trucks and 20 automobiles were flooded.
Great Bridge area	A low earth fill dike around a trailer camp was breached. Twelve stores and other commercial structures in Old Shopping Center flooded. About 75-80 homes had water in their garages and 20 houses in Bell's Mill area sustained damage. Ten automobiles were inundated.

Residences have been built at Great Bridge along Woodford Drive, around Great Bridge Boulevard, along Fernwood Farms Road, and along Shell Road between Military Highway and Interstate 64. These areas are characterized by new homes with relatively high first floor elevations.

Areas along Bells Mill Road, Millville Road, and Shipyard Road are characterized by older homes which appear to be at low elevations. One exception is the section of Bells Mill Road near the water. This section contains new homes with relatively high first floor elevations. The roads in these areas are low and residents must be careful not to become marooned during a major storm.

According to the civil defense coordinator in the Public Works Department, the enforcement of the State Building Code's requirement that first floor elevations be above the 100-year tidal flood stage has helped to mitigate damages. He stated that much of the area within the 100-year flood plain was developed following the promulgation of this regulation. As a result, most of the development in the tidal flood plain had first floor elevations above the 100-year tidal flood level. Only about 25 percent of the structures on the flood plain are below this level.

No measures to alleviate the tidal flood situation in Chesapeake were investigated in this report.

Hampton

This city is located on the shores of Hampton Roads and Chesapeake Bay. Much of the land is below elevation 10 and there are developments in areas as low as elevation 5. Generally the terrain slopes fairly uniformly from the higher elevations to sea level. There are no protective barriers such as sand dunes or continuous seawalls between the developed portion of the city and the surrounding water areas. Consequently, an increase in the level of Chesapeake Bay and other bodies of water which practically encompass the city cause flooding of land masses to the same level.

Figure A-40 shows a portion of Hampton and indicates the substantial areas that would be flooded. More than two-thirds of the land area of the city would be inundated by the standard project tidal flood (elevation 13) and approximately one quarter of the land area would be inundated by the 100-year tidal flood (elevation 8.5). It is estimated that about 20,000 people are located within the area affected by the latter flood. The Federal Emergency Management Agency has conducted a wave height study for Hampton. Wave heights that can be expected with the 100-year flood on both the Chesapeake Bay and the Hampton Roads sides would reach elevation 13. The wave heights drop back to stillwater levels quickly as the ground rises away from the coast. These factors along with the destructive effects of wave attack should be considered in a detailed study to evaluate their impact on the economic feasibility on possible tidal flood protection measures.

Fluctuations in water levels from approximately 1.3 feet above to 1.3 feet below mean sea level occur twice daily as a result of the normal astronomical tide. Minor flooding up to elevations 3 to 4 is associated with periods of moderately high sustained winds from the north, northeast, or east and may be experienced several times within any one year. Flooding of this magnitude is not serious and is unnoticed except for the temporary difficulties which may be expected by the fishing and other waterborne interests due to rough seas. The main source of concern is the large and infrequent floods which are associated with major storm events such as hurricanes and severe northeast storms. Storm surges which, together with the normal lunar tide produce water levels of elevation 5 or higher, cause widespread flooding in the city. Many times in the past, the city has been essentially paralyzed with practically all normal functions within the area brought to a standstill because of such flooding. An important factor to shorefront areas is that high water is generally associated with high waves which have inflicted structural damage to shorefront structures and eroded sand and other material from the beaches.

Some of the roads and bridges would be inundated during the 100-year tidal flood and practically all avenues of escape from large sections of the city would be impassable during the standard project tidal flood. Thus, the danger of becoming marooned in a low section of the city during the progress of a large flood is real and a very important factor.

Large areas were inundated by the 1962 storm. Over 600 families were isolated by the floodwaters. Hundreds of persons were evacuated to some of the schools. No deaths were reported. Considerable damage was caused to roads and drainage facilities. The damage, excluding loss to military installations, totalled $4,080,000. Table A-24 is a summary of the damage.

FIGURE A-40 COASTAL FLOODING IN HAMPTON, VIRGINIA

TABLE A-24

DAMAGES FROM MARCH 1962 NORTHEASTER IN HAMPTON

LOCATION	DAMAGE
Along Chesapeake Bay: Buckroe Beach	600 feet of concrete retaining wall, 200 feet of timber bulkhead, and an amusement park area and resort center were destroyed. 350 homes and 13 business establishments were damaged, many seriously impaired.
Grandview	One-half mile of retaining wall was almost completely destroyed. 50 homes and 2 businesses were damaged by water and waves.
Back River: Fox Hill (on Harris River)	250 residences and 6 business establishments were damaged.
Southwest Branch (Newmarket Creek)	Numerous residences and businesses sustained losses.
Hampton River: Downtown Hampton area	50 residences and 24 commercial establishments flooded.

Following the 1962 storm, the considerable erosion of the beaches at Buckroe and Grandview were rehabilitated by the Corps of Engineers with sand obtained from borrow areas.

Excerpts from the local newspaper, The Times Herald, for the August 1933 hurricane indicated that the heaviest property damage occurred at Buckroe Beach where 40 cottages were reportedly swept away. At Fox Hill, very few residences escaped flooding, some families having as much as 5 feet of water in their lower floors. Photographs of the 1933 and 1962 tidal flood scenes are shown in Figures A-41 through A-43.

A reconnaissance of the areas inundated by the 100-year storm in Hampton included:

a. the area adjacent to Hampton River,

b. the area adjacent to Harris River,

c. Buckroe Beach, and

d. Fox Hill and Grandview.

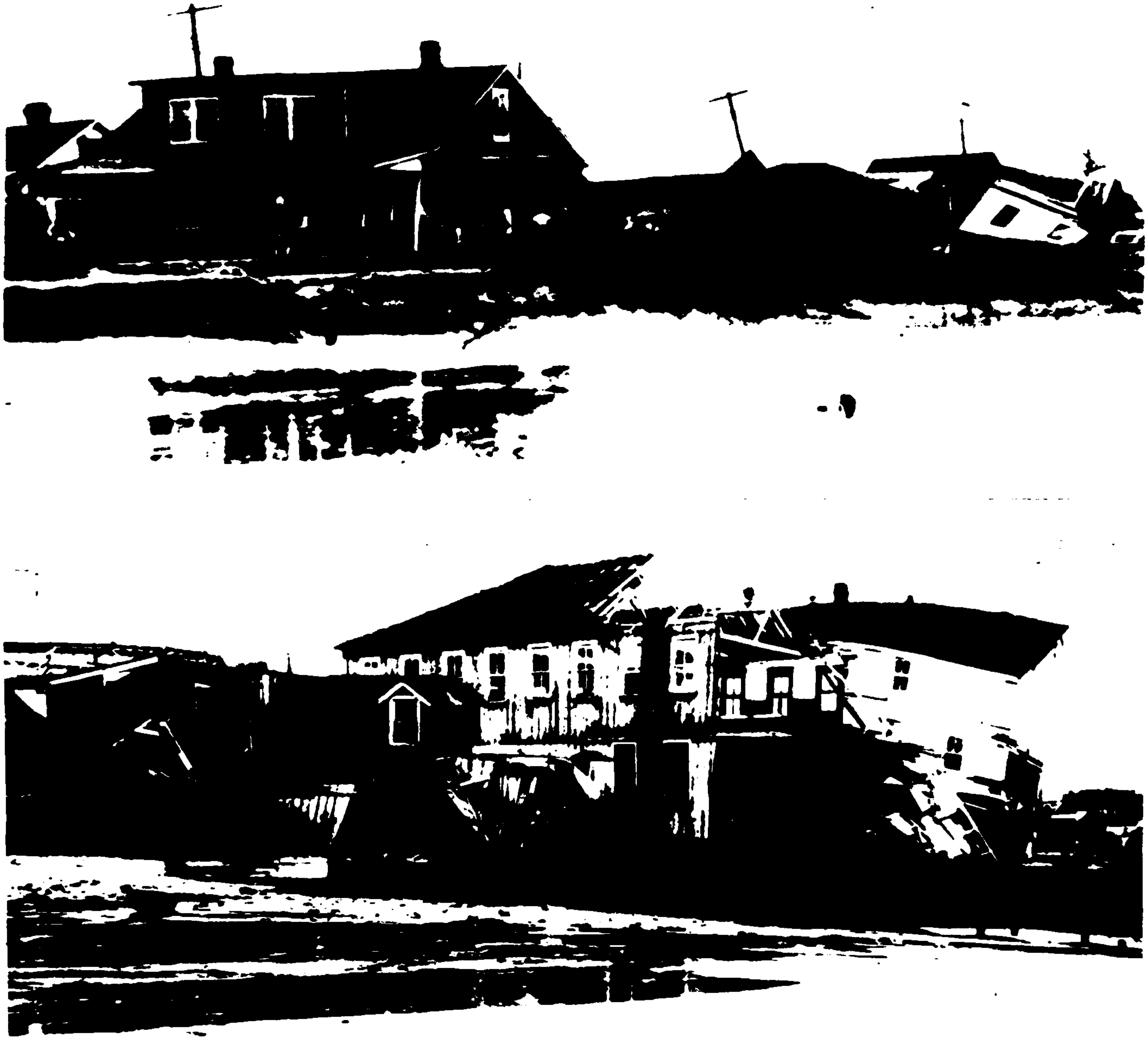
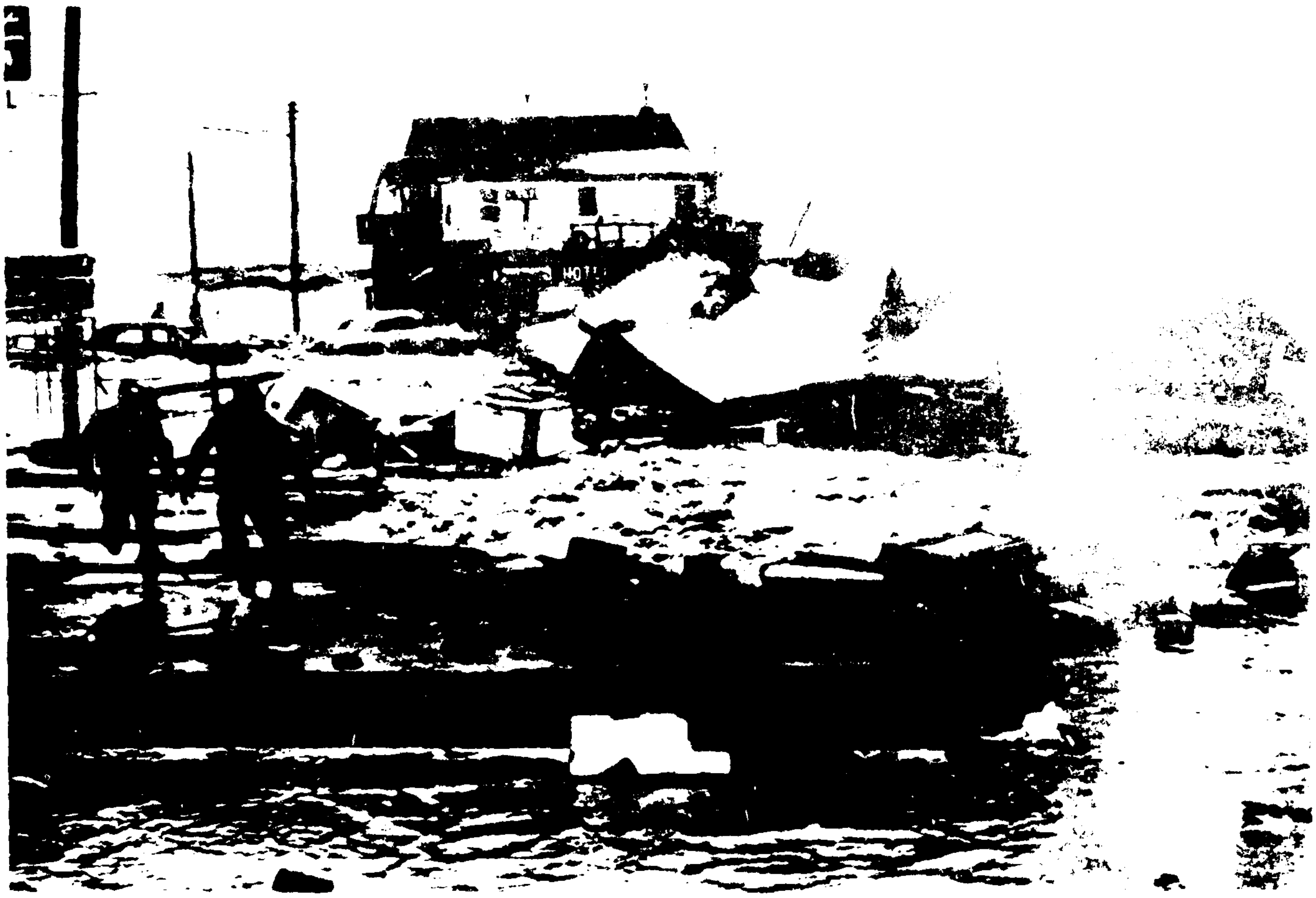


FIGURE A-41 AFTERMATH OF AUGUST 1933 HURRICANE IN HAMPTON



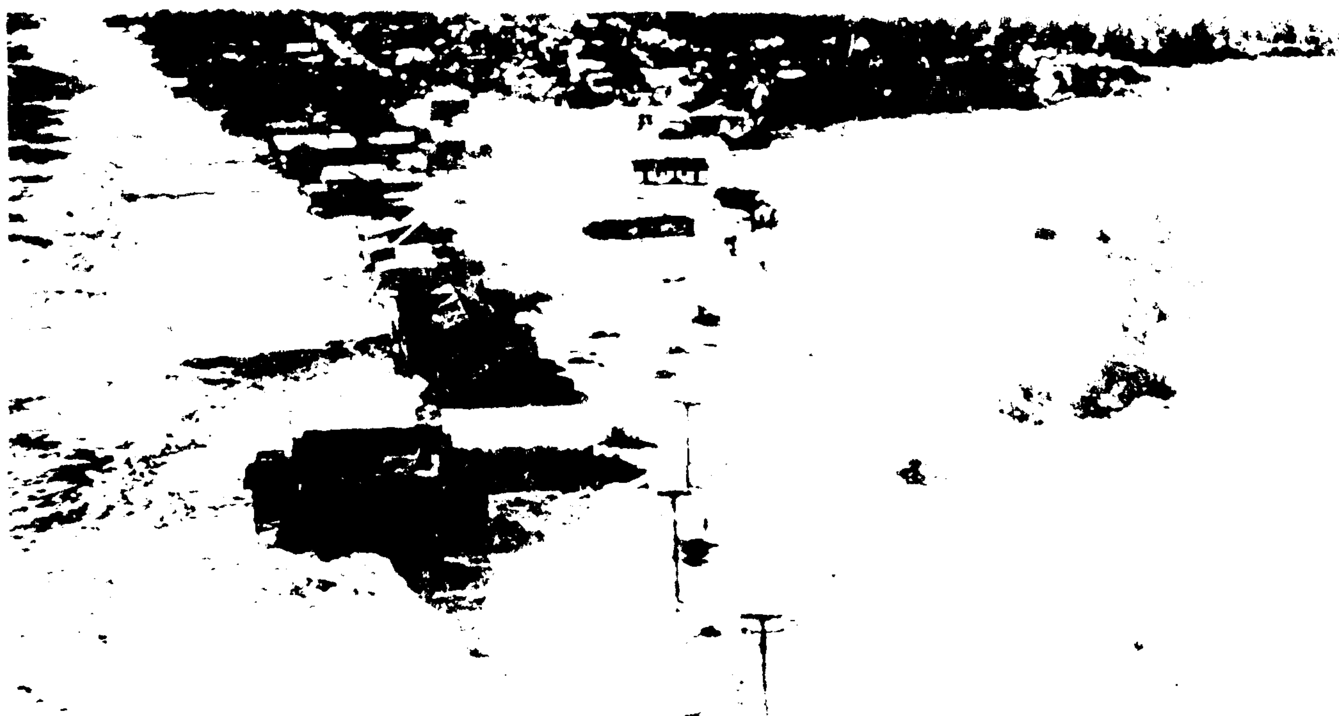


FIG.

FIGURE A-43 FLOODING IN HAMPTON - FOX HILL SECTION, MARCH 1962

Area Adjacent to Hampton River - This section includes mostly older homes and commercial establishments. The first floor of these homes appears to be low. There has also been some new housing built with the level of the first floor at a relatively high elevation.

A plan for protection of the Hampton River area including the downtown section was considered in 1964. The protective works would include 5,400 feet of earth dike and concrete wall to elevation 12, providing protection to elevation 10. A navigation opening at Hampton River would have a clear span of 80 feet. Sufficient storage would be available in Hampton River up to elevation 4.5 to pond the surface runoff during times when the navigation gates across the mouth of this stream are in a closed position. Pumping stations would need to be built at John's Creek and one adjacent to the sanitary sewers along Kecoughtan Road. Also some roads would be raised. The cost of such a plan was estimated at $4.2 million, the annual charges at $183,000, and the average annual benefits at $102,000. This provided for a benefit-cost ratio of 0.6 indicating that such a project was not economically feasible. In view of the new development and renewed interest in the area, it should be further investigated to determine the economic justification of tidal flood protective measures.

Area Adjacent to Harris River - The area in the vicinity of Fort Worth Road includes new homes. A housing development is being constructed along the river. These are substantial homes and they appear to have a relatively high first floor elevation. This is in keeping with the State Building Code requirement that the first floor elevation be at or above the level of the 100-year tidal flood.

Buckroe Beach - Buckroe Beach contains an older resort section as well as one including new housing. The older area contains housing, motels, and commercial establishments including an amusement park. The new housing is very substantial and much of it is multi-family. A plan for the protection of Buckroe Beach was considered in 1963. It included the construction of 4,200 feet of seawall along Chesapeake Bay and 4,600 feet of earth dike connecting the ends of the seawall with high ground. Protection would be provided to elevation 10. Because of the exposed position of the area and the open waters of Chesapeake Bay, it would be necessary for the top of the wall to be built to a much higher level in order to properly take care of wave action, thereby blocking the view of the Bay. The cost of such protective works was estimated to be in excess of $2 million. To be economically justified, at least $80,000 in average annual damages would have to be sustained. Based on the development existing in the area in 1963, this did not appear to be the case. The new development and improvement in the existing areas warrants a study to assess their impact on the economic justification of protective works.

Fox Hill and Grandview - These sections appear to consist of older homes and commercial establishments. The first floor of the homes is low and susceptible to flooding by the 100-year storm. The roads appear to be low and pose a threat to the residents who may become marooned during a major storm.

During discussions with the City Engineer, he stated that following a major storm, he would not object to the placement of high water markers at strategic locations. He further stated that the State Building Code requiring first floor levels at the 100-year flood stage was helping in easing the flood problem. He believed that enforcement of

this code, public education relative to the tidal flood problem, and encouragement in the purchase of Federal flood insurance appeared to be the only action the city could take in this matter.

The Civil Defense Coordinator stated that Hampton, along with every community along lower Chesapeake Bay, had a detailed plan to follow in the event of a hurricane or northeaster. He stated that there was no way to keep people from living close to Chesapeake Bay or its tributaries. He believed that the best his office could do was to educate the people to the potential danger and to provide proper evacuation and shelter during a major storm.

POQUOSON, VIRGINIA

ALTERNATIVE FUTURE CONDITIONS

According to the Comprehensive Plan for the City of Poquoson, adopted May 25, 1976, the existing land use for the city, in acres, is as follows:

Residential, single family		1,830
Residential, other		32
Commercial, industrial and public		128
	Subtotal	1,990
Undeveloped		7,960
	Total	9,950

Residential use has grown; however, the average size of a single-family residential lot has decreased from one acre to approximately one-third of an acre. This is due primarily to the availability of public water and sewer.

Of the undeveloped area, 1,800 acres are wetlands. They, along with some of the larger creeks, bring the total to 2,900 acres which have been designated for conservation.

The future land use in acres is estimated in the Comprehensive Plan as follows:

Residential		6,400
Commercial-industrial park		400
Waterfront commercial		100
Public use		150
Wetlands and conservation areas		2,900
	Total	9,950

The largest category of developed land will be residential containing primarily low to medium density housing with no more than four units per acre.

VIEWS AND DESIRES OF LOCAL INTERESTS

According to the former Assistant City Manager, the city and its inhabitants are quite aware of the seriousness of the tidal problem. He emphasized that Poquoson is one of the fastest growing cities in the state. Thus, he is not aware of any land in the city or adjacent thereto that would be available for relocating low-lying houses at a reasonable cost. He believed that the purchase and demolition of houses would present a very serious problem. There are strong family ties to the property, no matter what its physical condition. Furthermore, if these residents receive relatively small amounts for their property plus relocation expenses, it would be very difficult to find comparable homes with this amount of money. According to city officials, many residents have almost accepted the flooding as a fact of life. They are very reluctant to leave their houses during flooding preferring to raise their belongings and stay. Other residents find it necessary to come to the Middle School for protection during high tidal waters almost every other year on an average.

The former Assistant City Manager strongly suggested in 1980 that the people in the low-lying area be told that:

a. Their homes would be demolished,

b. Fill would be placed on the land to raise its level, and

c. A new house would then be built with possibly some subsidization by HUD.

The former Assistant City Manager stated that consideration might be given toward construction of a building or a wall around an existing structure so that 500 to 600 people could come to this location during a major tidal flood. It is understood that the Middle School is now used for this purpose.

There is also concern about drainage following an unusually high tide. The existing drainage system is inadequate. Thus when heavy rainfall occurs or tidal waters reach the area, it takes a long time for floodwaters to run off. Local officials believe that if drainage were faster, this would mitigate flood levels around existing homes.

RESOURCE MANAGEMENT PROBLEMS

Large sections of Poquoson have been subjected to tidal flooding in varying degrees of intensity many times in the past. Past flooding indicated by high water marks has been as high as elevation 9. Many developed areas are at elevation 5 or below. During periods of high tidal flooding, the shoreline is subject to wave action across the low marsh areas and shallow inlets and creeks.

The greatest known flood in the Poquoson area occurred in August 1933. It was the result of a hurricane which swept northward past Poquoson on a path along the axis of Chesapeake Bay. Maximum tide heights during this flood reached elevation 9, based on high water marks, with an average height of about 8.3. During the August 1933 storm, the local newspaper, The Daily Press, stated that Poquoson was inundated. About 50 men, women, and children were driven from their homes at Messick Point after watching their household goods float away. They found themselves without clothing, shelter, and food.

Another great flood in March 1962, the result of a northeaster, was the second largest ever recorded at Poquoson. Although the second largest in height of stage reached, this flood was the most severe of record in terms of monetary damage along the Virginia coast. Hundreds of homes were flooded, some by as much as 2 to 4 feet. About 200 persons were evacuated and a number of others left on their own initiative. There was no loss of life. By the nature of its development, damages were widely dispersed in the area, and the flood losses amounted to $500,000. Flood scenes of this area are shown in Figures A-44 thru A-47.

A flood that may be expected once in 100 years (although it could occur more often and in any year) would inundate almost the entire city. In some residential areas of the city, there would be 4 feet of water or more that would be standing in the yards and on the roads. The danger of becoming trapped in one's home in this type of flood is very real. This flood or one even higher would be much more destructive and dangerous if evacuation plans are not carried out before the roads in the area become impassable. There should also be a place for the people of the city to take refuge from the storm. This place should be flood proofed to a high level of protection.

There is no recording gage at Poqouson. However, other recording stations indicate flooding conditions that occur along the Virginia coastline. Table A-25 shows the location and record for stations in Hampton Roads and comparable high water data obtained for Poquoson.

TANGIER ISLAND, VIRGINIA

ALTERNATIVE FUTURE CONDITIONS

Conditions on the island are not expected to change much in the future. Virtually all the available land, other than marsh, is occupied. The primary use is residential with several commercial or service buildings. Since the entire island is on the flood plain, any new structures would have to be flood proofed or raised. In many cases, children who wish to remain on the island may marry and move into trailers on the small lots owned by their parents. With population density on Tangier greater than any other incorporated town on the Eastern Shore of Virginia, it is believed that population growth is not likely in the future.

VIEWS AND DESIRES OF LOCAL INTERESTS

Most of the people's concern is presently oriented toward the erosion problem that threatens the island. The erosion has exceeded 30 feet in recent years, according to an observer. The erosion at the south end of the air strip is acute. Where the shoreline has not been protected by riprap, the only retarding features are the plants that grow at the shoreline. Here the water is making serious cuts into the island. The islanders are anxious for the Corps of Engineers and State of Virginia to initiate construction of a low level wall along the western shore of the island primarily to deter the erosion. Plans have been completed with State funds and it is hoped that construction funds will be appropriated by the Congress or the State or made available by private interests.

FIGURE A-44 FLOOD SCENE OF MARCH 1962 "NORTHEASTER" AT POQUOSON, VIRGINIA

FIGURE A-45 FLOOD SCENE OF MARCH 1962 "NORTHEASTER" AT POQUOSON, VIRGINIA

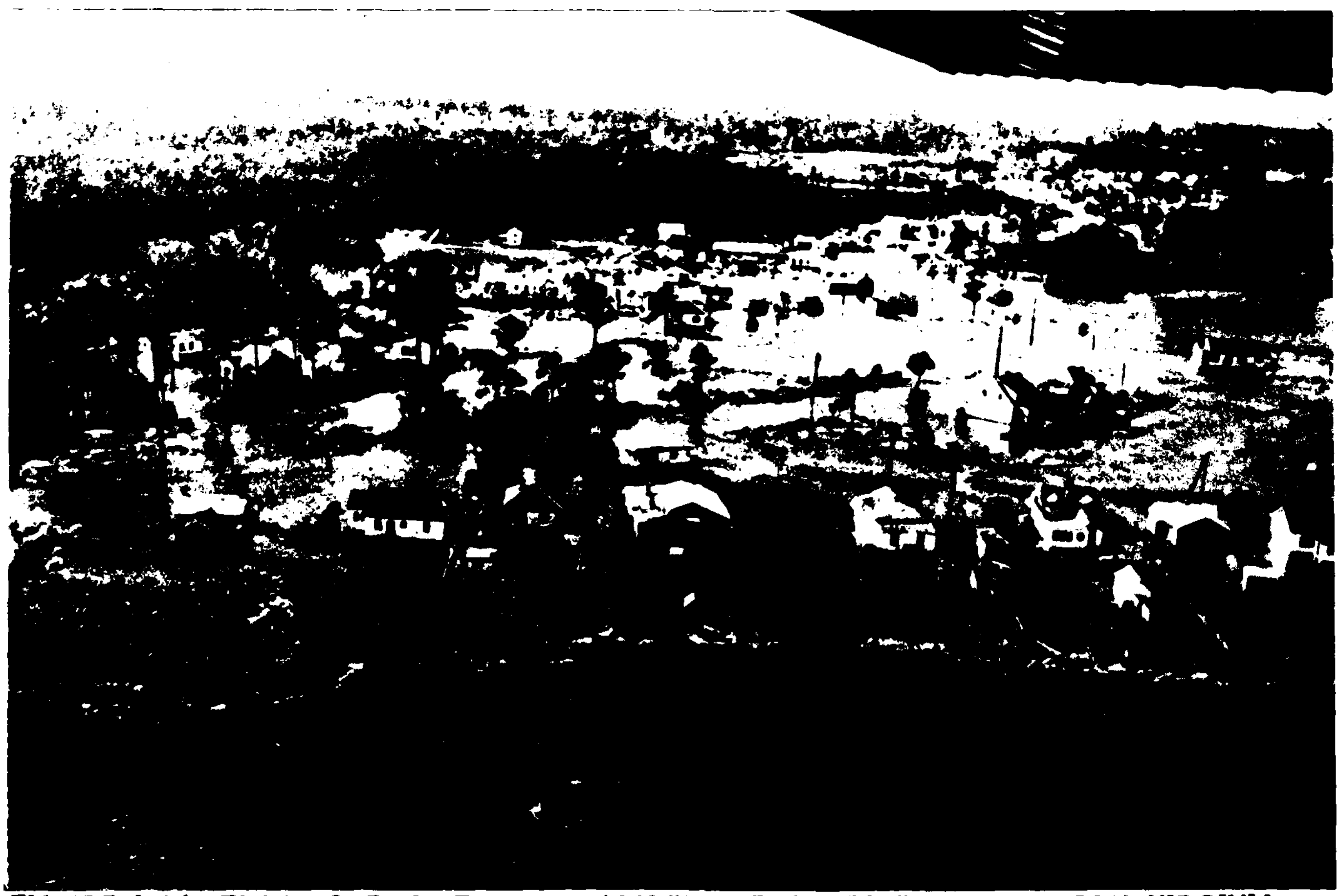


FIGURE A-46 FLOOD SCENE OF MARCH 1962 "NORTHEASTER" AT POQUOSON, VIRGINIA

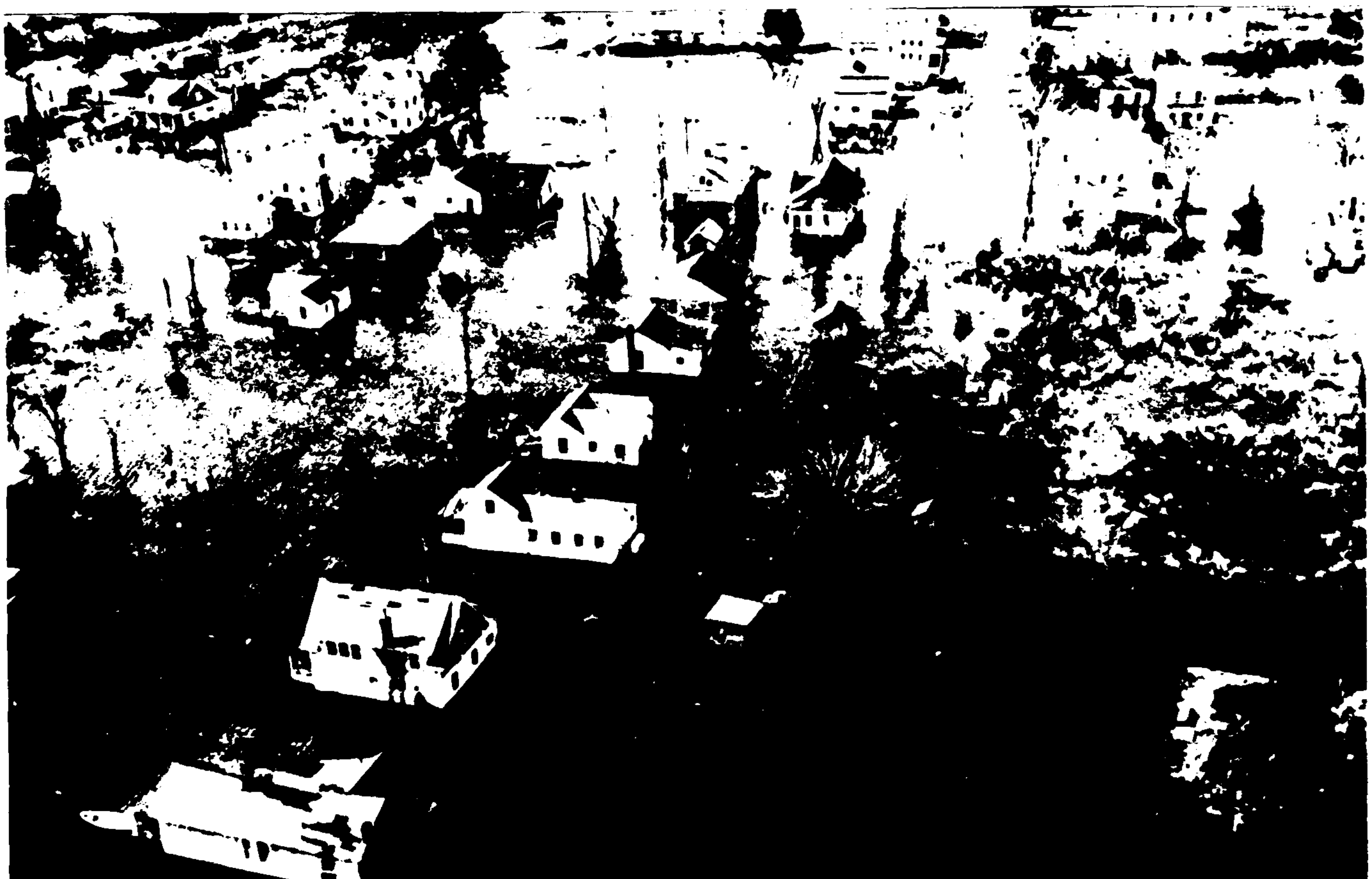


FIGURE A-47 FLOOD SCENE OF MARCH 1962 "NORTHEASTER" AT POQUOSON, VIRGINIA

TABLE A-25

TIDAL FLOOD ELEVATIONS - HAMPTON AND POQUOSON
(Maximum elevation, feet msl)

DATE OF FLOOD		HAMPTON ROADS[1] 1927-DATE	NORFOLK HARBOR[2] 1908-DATE	(9)	OLD POINT COMFORT 1937-1945 1948-1955		POQUOSON		GLOUCESTER POINT 1950-DATE	
August 23, 1933	7	7.5	8.0	8.05	8.6	3	8.3	6	--	
March 7, 1962	8	6.7	7.4	7.06	6.8	4	6.4	6	5.9	5
September 18, 1936	7	6.2	7.5	7.55	—		--		--	
April 11, 1956	8	5.8	6.5	6.34	5.8	5	5.8	6	4.9	
September 16, 1933	7	5.6	6.3	6.34	—		--		--	
September 12, 1960	7	5.5	6.3	6.09	4.8	4			5.8	
September 27, 1956	7	5.4	5.9	5.74	—		--		5.0	
October 6, 1957	8	5.1	5.8	5.53	5.2	4	5.2	5	3.9	
October 5, 1948	7	4.9	5.4	5.35	5.0		--		--	
September 18, 1928	7	4.8	5.8	5.85	—		--		--	

[1]Ten highest tides at Hampton Roads are listed (Sewells Point Gage).
[2]U.S. Naval Shipyard, Portsmouth, Virginia.
[3]Based on data by U.S. Coast and Geodetic Survey.
[4]Based on maximum tide indicator.
[5]Estimated from high water data.
[6]Average of high water marks.
[7]Hurricane.
[8]Northeaster.
[9]Maximum elevation feet, National Geodetic Vertical Datum, taking into account sea level and leveling accomplished by USGS.

RESOURCE MANAGEMENT PROBLEMS

The people of Tangier indicated that they do not mind the high tide that comes up to the roads. The last time that they had an unusually high water level was during the March 1962 storm, see Figure A-48. Very few houses were flooded during this storm.

In 1980, a diligent search was made by the staff of the Norfolk District Office for high water data on past tidal floods. Mayor Robert Thorne, Mr. Vernon Bradshaw, and Mr. Harold G. Wheatley, Principal of the Tangier School and emergency coordinator, stated that they knew of no high-water marks for past flooding. Messrs. Wheatley and Bradshaw were old enough to remember the August 1933 storm. They indicated that large boats floated up onto the road in the vicinity of Haynes Marine Supply Store. Fishing vessels of that time had a minimum draft of 4 feet with about 1 foot under their keel. Based on these data, the 1933 tidal flood would have reached a stage of about 5 feet over the road in this vicinity. The topographic map for Tangier shows the 2-foot contour crossing the road in the vicinity of the Haynes Marine Supply Store. Therefore, as can best be ascertained, the 1933 tidal flood reached an elevation of about 7 feet above mean sea level. According to the U.S. Geological Survey, the three ridges that are inhabited now are below elevation 5 as are the salt marshes that surround the island. Thus a major storm that would inundate the entire island (south) would threaten the safety and lives of the entire population. Escape by boat, helicopter, or plane to the mainland would not be practical.

WEST POINT, VIRGINIA

ALTERNATIVE FUTURE CONDITIONS

West Point is dependent on The Chesapeake Corporation, a paper manufacturing company, and on the surrounding agricultural countryside for its existence. There are numerous logging and forestry operators in the area. The farms in the county compare favorably in terms of value of farm products sold with farms on a statewide basis. Its population in 1978 was 8,600 with a projection to 12,700 in 2,020. By comparison, West Point had a population of 2,726 in 1980.

It is anticipated that future conditions in West Point will remain about the same as they are at present. The same expansion in residences and possibly commercial developments can be expected, generally to the north, as the population increases proportionately to the increase in the county. Any future development along the waterfront will have to consider the regulations of the Federal Insurance Administration and the Commonwealth of Virginia for raising the first floor of structures up to the level of the 100-year flood.

VIEWS AND DESIRES OF LOCAL INTERESTS

While there are flood problems in the Town of West Point, there does not appear to be an indication that it is of a high priority. However, according to the plant engineer for The Chesapeake Corporation, the company is very concerned about floodwaters. Much of the equipment has been raised up to elevation 8, and this is continuing.

FIGURE A-48 FLOOD SCENE IN TANGIER ISLAND, MARCH 1962

RESOURCE MANAGEMENT PROBLEMS

The town manager has stated that there was a flood problem along 1st and 14th Streets. First Street extends along the waterfront at the southern limits of the town and it experiences tidal flooding. The 14th Street area floods from a combination of tidal waters and local runoff which surcharges the storm sewers. The sewers should be enlarged. The northern limit of the town near the high school has a local drainage problem.

As previously stated, The Chesapeake Corporation is very concerned about floodwaters. The plant engineer furnished a list of equipment that would be flooded and their elevations. A study of this information and an inspection of the plant indicate that there are many pumps, motors, tanks, and other equipment at elevations ranging from 3 to 12, the latter being the Corps estimate for the Standard Project Flood. The plant engineer stated that elevation 5 to 5.5 is a common occurrence in hurricanes and elevation 11 to 12 would be a most unusual occurrence. Consequently, the company has adopted a policy to have a program, whereby all plant, machinery, and equipment will be raised to elevation 8.

Data on the heights of past major storms at West Point are lacking. The Virginia State Water Control Board installed a gage in September 1968, but it was removed recently.

The U.S. Coast and Geodetic tide gage at Gloucester Point has been in existence since 1952. The highest tide observed was about 7.9 during the northeaster on 7 March 1962 or 6.46 above mean low water or 5.5 feet above mean sea level. According to the Coast and Geodetic Survey, the height of flooding at West Point is somewhat higher than at Gloucester Point. In a storm tide of the 1962 magnitude, it is difficult to determine the exact height at West Point. The range for this storm is estimated to vary from 5.7 to 6.4 with an average of about 6 feet above mean sea level.

The plant engineer for The Chesapeake Corporation stated that, in the past 25 years, high water resulting from hurricanes and/or northeasters has not reached above elevation 5 to 5.5. He bases this on the fact that the floor of the machine shop and storeroom is elevation 5.1 and storms have not exceeded this level by more than a few inches in the past 25 years. The plant engineer resided in West Point during the August 1933 hurricane. He stated that the water reached a stage of from 11 to 12 feet at The Chesapeake Corporation plant. This is based on a depth of 5 to 6 feet of water over the basement floor of the power plant which is at elevation 6.41. Undoubtedly, this unusual height was due to the 1- to 2-mile width and 22-foot depth of the York River with wind driving the waters upstream in the 33-mile fetch of river to West Point.

CHESAPEAKE BAY

TIDAL FLOODING STUDY

APPENDIX B

PLAN FORMULATION, ASSESSMENT
AND EVALUATION

Department of the Army
Baltimore District, Corps of Engineers
Baltimore, Maryland
September 1984

CHESAPEAKE BAY TIDAL FLOODING STUDY

APPENDIX B - PLAN FORMULATION, ASSESSMENT AND EVALUATION

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APPENDIX B

PLAN FORMULATION, ASSESSMENT AND EVALUATION

INTRODUCTION

As the historical development of the Bay Region has been tied in large part to the Bay itself, considerable development has taken place along the Bay shoreline. Over the years the developing and developed shoreline areas have been subjected to periodic tidal flooding. The damages have been substantial. Damages sustained have included loss of life and property, hazards to health, disruption of normal economic activities, evacuation costs, and rehabilitation costs. The primary difficulty as it relates to tidal flooding is the conflict between a natural process and man's existing and proposed use of the tidal flood plain.

The Chesapeake Bay Tidal Flooding Study was authorized by Section 312 of the River and Harbor Act of 1965, adopted on 27 October 1965. The authorization follows:

> (a) The Secretary of the Army, acting through the Chief of Engineers, is authorized and directed to make a complete investigation and study of water utilization and control of the Chesapeake Bay Basin, including the waters of the Baltimore Harbor and including, but not limited to, the following: navigation, fisheries, flood control, control of noxious weeds, water pollution, water quality control, beach erosion, and recreation. In order to carry out the purposes of this section, the Secretary, acting through the Chief of Engineers, shall construct, operate, and maintain in the State of Maryland a hydraulic model of the Chesapeake Bay Basin and associated technical center. Such model and center may be utilized, subject to such terms and conditions as the Secretary deems necessary, by any department, agency, or instrumentality of the Federal Government or of the States of Maryland, Virginia, and Pennsylvania, in connection with any research, investigation, or study being carried on by them of any aspects of the Chesapeake Bay Basin. The study authorized by this section shall be given priority.
>
> (b) There is authorized to be appropriated not to exceed $6,000,000 to carry out this section.

An additional appropriation for the Chesapeake Bay Study was provided in Section 3 of the River Basin Monetary Authorization Act of 1970, adopted on 19 June 1970. This section reads as follows:

> In addition to the previous authorization, the completion of the Chesapeake Bay Basin Comprehensive Study, Maryland, Virginia and Pennsylvania, authorized by the River and Harbor Act of 1965 is hereby authorized at an estimated cost of $9,000,000.

In June 1972, Tropical Storm Agnes moved through the Mid-Atlantic states causing extensive damage to the resources of Chesapeake Bay. Public Law 92-607, the Supplemental Appropriation Act of 1973, was signed on 31 October 1972, and included $275,000 for additional studies of the storm's effect on Chesapeake Bay.

In response to this authorization three major objectives of the Chesapeake Bay Study were identified. These objectives were to: 1) assess the existing physical, chemical, biological, economic, and environmental conditions of Chesapeake Bay and its water resources, 2) project the future water resources needs of Chesapeake Bay to the year 2020, and 3) formulate and recommend solutions to priority problems using the Chesapeake Bay Hydraulic Model. The publication of the Existing Conditions Report in 1973 and the Future Conditions Report in 1977 marked the achievement of the first and second objectives. These reports also provided the framework for investigation and evaluation of those Bay-wide problem areas thought to be of priority to the Region. Figure B-1 indicates the extent of the Chesapeake Bay Region.

In pursuit of the third objective of the Chesapeake Bay Study several priority concerns were identified. Two of the most pressing problems identified included the impact of low freshwater inflows to the Bay, and the impact of tidal flooding on those Chesapeake Bay communities subject to flooding. These two problems became the focus of the detailed study phase of the Chesapeake Bay Study.

PURPOSE OF APPENDIX

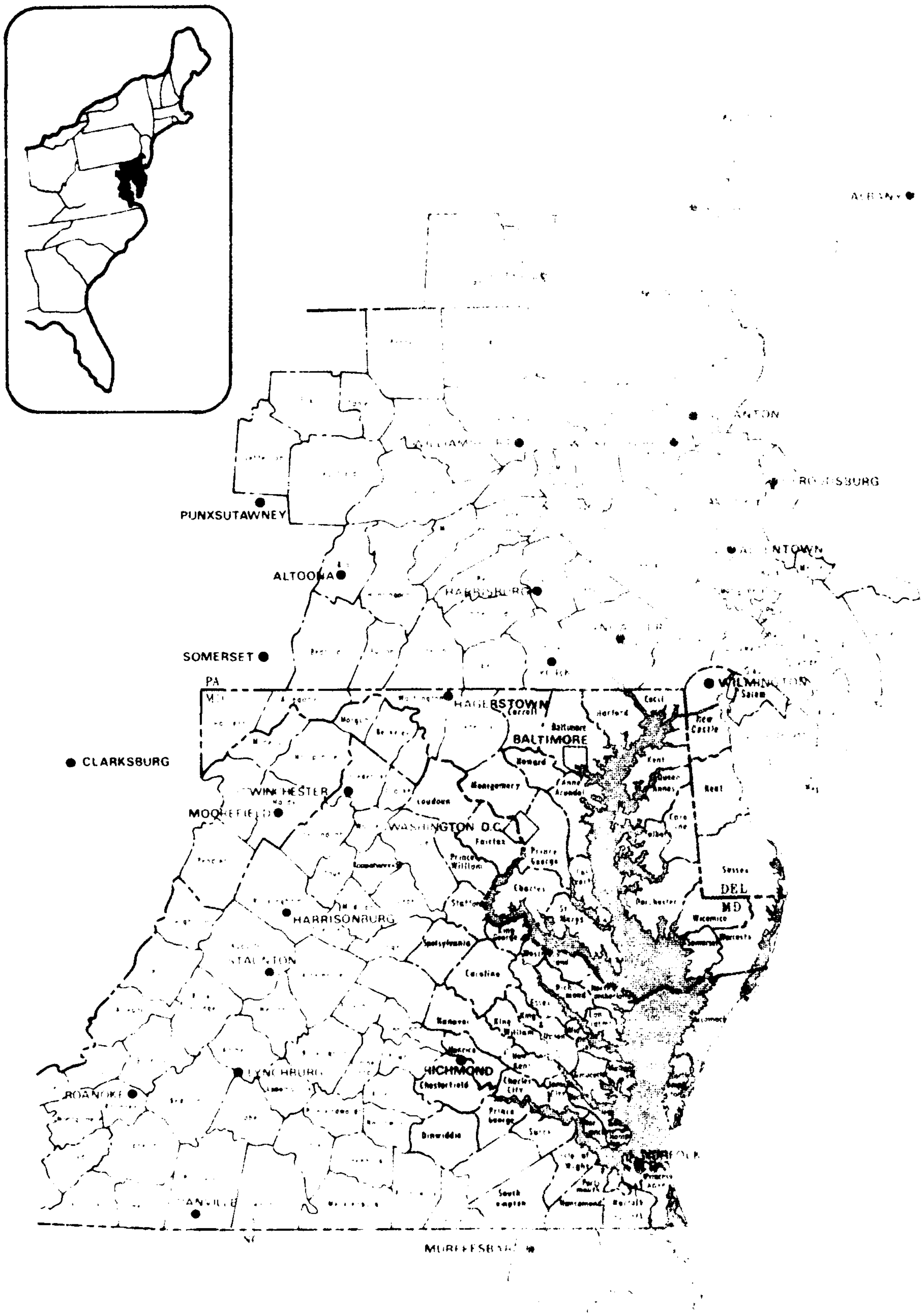
The purpose of this appendix is to present information on the formulation, assessment, and evaluation procedures used for plans which sought to satisfy planning objectives by providing flood protection for selected Bay communities. This appendix summarizes the objectives, methodologies, technologies, criteria, plan components and design considerations as well as the formulation procedures leading to community selection and detailed problem analysis. This plan formulation, assessment, and evaluation document is further supported by data and analytical methods more fully described in other appendices and annexes to the Tidal Flooding Study Report. These volumes are referenced throughout the text where appropriate and are listed in Table B-1 for informational purposes.

STATEMENT OF PLANNING OBJECTIVES

Planning objectives were established to guide the formulation and evaluation of flood protection plans. Simply stated, the objectives provided the yardstick against which the alternative plans were measured. Two levels of objectives were considered important for the Chesapeake Bay Tidal Flooding Study. National planning objectives and study planning objectives.

NATIONAL PLANNING OBJECTIVES

Guidelines for the formulation and evaluation of plans of improvement for all Federal water and related land resource activities were contained in the Water Resources Council's "Principles and Standards for Planning Water and Related Land Resources," established pursuant to Section 103 of the Water Resources Planning Act (P.L. 89-80). These Principles and Standards required that Federal and Federally-assisted water and land activities be planned toward achievement of National Economic Development (NED) and Environmental Quality (EQ) as co-equal national objectives. The components of the NED objective included:



PUNXSUTAWNEY
ALTOONA
SOMERSET
CLARKSBURG
PA
HAGERSTOWN
BALTIMORE
WILMINGTON
MOOREFIELD
WASHINGTON D.C.
HARRISONBURG
STAUNTON
LYNCHBURG
ROANOKE
RICHMOND
DEL
MD

TABLE B-1

CHESAPEAKE BAY TIDAL FLOODING
STUDY REPORT FORMAT

APPENDIX	APPENDIX TITLE
—	Main Report
A	Problem Identification
B	Plan Formulation, Assessment, and Evaluation
C	Recreation and Natural Resources
D	Social and Cultural Resources
E	Engineering Design and Cost Estimates
F	Economics

- The value of increased outputs of goods and services resulting from a plan.

- The value of output resulting from external economies associated with a plan.

The components of the EQ objective included:

- Management, protection, enhancement, or creation of areas of natural beauty or human enjoyment.

- Management, preservation, and/or enhancement of especially valuable or outstanding archeological, historical, biological, or geological resources and ecological systems.

- Enhancement of quality aspects of water, land, and air by control of pollution or prevention of erosion and restoration of eroded areas.

- Avoiding irreversible commitments of resources to future needs.

The NED objective sought to achieve the maximum net benefits from a National viewpoint while the EQ objective sought to maximize environmental benefits (and the least amount of adverse impacts) measured primarily in non-monetary units. In formulating alternative plans to maximize these National objectives, trade-offs occurred. These trade-offs were considered with reference to the without condition. When plans were to be finalized, the impacts and trade-offs of each were tabulated to aid decision-makers in selecting a program for further consideration.

The Principles and Standards promulgated by the Water Resources Council provided the basis for the water resources planning procedures followed during the Tidal Flooding Study. The Tidal Flooding Study was initiated and conducted under these guidelines and the findings and conclusions presented reflect the Principles and Standards. It should be noted, however, that on 9 September 1982, the WRC repealed the Principles and Standards and, in their place, established new "Principles and Guidelines."

The major change resulting from the implementation of the Principles and Guidelines is that the co-equal national objectives of NED and EQ have been combined into one Federal objective. The Federal objective of water and related land resources planning is to contribute to national economic development consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements.

STUDY PLANNING OBJECTIVES

Within the framework of National objectives, a second level of planning objectives was developed which related to the problems, needs, concerns, and opportunities of the specific study area. Study planning objectives are expressions of public and professional concerns about the future use of water and related land resources. They were derived through an analysis of the existing resource base and the expected future conditions within the study area. The purpose in defining study planning objectives was to establish "targets" to guide the formulation of alternative plans and to enable evaluations of the plan effectiveness. Planning objectives sometimes conflicted with each other, reflecting different perceptions of how the water resources should be managed in the future.

During the early phase of the planning process, the planning objectives were general in scope and often many in number. Based on the existing and future problems, needs, and opportunities identified during the initial iterations of the planning process, including the preparation of the Chesapeake Bay Existing Conditions and Future Conditions reports, the following were recommended as planning objectives for the expanded Chesapeake Bay Study program:

- Preserve, restore, and enhance the integrity of the Chesapeake Bay ecosystem.
- Manage, preserve, and enhance areas of significant natural, historical, cultural, and scientific interest for the inspiration, enjoyment, and education of man.
- Assure sufficient quantities of water to meet the needs of domestic, municipal, industrial (including power plants), and agricultural users.
- Assure water of suitable qualities for all intended or potential water resource uses.
- Maintain, enhance, and/or increase water-based recreational opportunities.
- Maintain, enhance, and/or increase the commercial and sport fishing opportunities and resources.
- Maintain or improve water navigation facilities which provide transportation advantageous to the Nation's transportation system.
- Reduce tidal flooding damages.
- Reduce damages due to shoreline erosion.

- Develop power facilities where its provision can contribute to a needed increase in power supply.

- Control the occurrence of certain aquatic plants where they interfere with man's use of the Bay.

- Maintain or improve adequate outlets for approved on-farm drainage systems for surface water management.

As they related more directly to the tidal flooding problem, which is the subject of this report, the following are the specific planning objectives for the communities under study.

- Protect life and property.

- Reduce flood damages and health hazards due to flooding.

- Minimize adverse impacts on cultural resources and the natural environment.

- Minimize adverse impacts on aesthetic values and community cohesion.

- Avoid inducing any additional flood plain damages.

SELECTION OF COMMUNITIES FOR DETAILED STUDY

Existing flood problem areas were identified by considering the degree of tidal flooding that would be experienced by those communities located along the shoreline of the Bay and its tributaries. The initial step in the analysis was to identify all Bay communities with a population of 1,000 or greater that are located either in total or in part within the Standard Project Tidal Flood (SPTF) Plain. The Standard Project Tidal Flood is defined as the largest tidal flood that is likely to occur under the most severe combination of meteorological and hydrological conditions that are considered reasonably characteristic of the geographic region. The Corps of Engineers in cooperation with the U.S. Weather Bureau (now the National Weather Service) determined that for the Chesapeake Bay Region the SPTF would average approximately 13 feet above National Geodetic Vertical Datum (NGVD). The above figure is a static or standing water surface elevation which would occur in conjunction with an astronomical high tide and does not include the effects of waves. Wave heights are dependent upon wind speed and direction, depth of water, fetch (the distance the wind blows over the water in generating the waves) and the length of time the wind blows. Assuming average values for water depth and fetch and superimposing winds characteristic of a hurricane that would produce a tidal surge of 13 feet above NGVD, wave heights on the Bay could be 5 feet in height. Based on the above combination of tidal surge and wave action the SPTF would inundate all areas up to approximately 18 feet above NGVD. Because average conditions were used in determining the SPTF elevation and for ease in delineating the flooded area, an elevation of 20 feet NGVD was assumed for purposes of the analysis.

The next step in the flooding analysis was to identify those communities that should be classified as "flood-prone." In order for a community to be designated as flood-prone, at least 50 acres of land that were developed for intensive use had to be inundated by the

SPTF. Intensive land use was defined as residential (four dwelling units/acre or greater), commercial (including institutional), or industrial development. The Bay Region communities identified as flood-prone are listed in Table B-2. Approximately 82,000 acres of land were located in the Standard Project Tidal Flood Plain.

The last step in the initial screening process was to determine those communities considered to be "critically" flood-prone. The flood problem was considered to be "critical" if 25 acres or more of intensively developed land were inundated by the 100-year flood. Those communities found to be "critical" based on the above criteria are marked with an asterisk in Table B-2. It should be noted that the elevations used for the 100-year flood were approximated based on the best available historical information.

During the preparation of the Revised Plan of Study, a further screening of those critical communities listed in Table B-2 was conducted. This screening eliminated those communities where it was evident that flood protection would not be acceptable to the community. This determination was based on the fact that many strictly residential communities are located along the Bay's shoreline for aesthetic as well as recreational reasons and a structural solution would require, in most cases, a flood wall of excessive height. This type of structure would impact upon the use of the shoreline for recreation and would cause visual disruption of the shoreline environment. In these communities, the expressed concern is related to the erosion of land that takes place during tidal storms, instead of the damages that result from temporary inundation of house and property. Application of nonstructural solutions in these same areas, such as floodproofing and relocation is also inappropriate. Many of the structures are old and not suitable for major floodproofing modifications. Furthermore, these areas were established adjacent to the shoreline to take advantage of the resource, thus making relocation unacceptable.

Based on the above considerations, the communities recommended for detailed study in the Revised Plan of Study were limited to those listed in Table B-3. All the recommended communities were considered to have highly developed flood-prone areas where the potential existed for providing some form of flood protection. The Revised Plan of Study further recommended that the second stage of the planning process concentrate on refinement of environmental, economic, social and hydrologic data and the formulation and evaluation of various flood damage reduction measures.

With the approval of the Revised Plan of Study, Stage II studies were initiated for the communities listed in Table B-3. As a result of these initial studies several additional communities were eliminated from further consideration. Smith Island, Maryland, and Colonial Beach and Virginia Beach, Virginia, were eliminated as detailed studies of these communities were being conducted under specific study resolutions and any further effort under the Chesapeake Bay Program would have been duplicative. Denton and Salisbury, Maryland, were both eliminated when preliminary stage-damage surveys and more detailed mapping and flood plain delineation indicated that the flood problem was limited to only scattered development at frequencies in excess of once in 100 years. Likewise, Fredericksburg, Virginia, was eliminated when fluvial rather than tidal flooding was found to be the problem.

TABLE B-2

CHESAPEAKE BAY AREA
FLOOD-PRONE COMMUNITIES

STATE OF MARYLAND

Anne Arundel County
*Arundel on the Bay
*Avalon Shores (Shady Side, Curtis Pt. to Horseshoe Pt. and West Shady Side)
Broadwater
Columbia Beach
*Deale
Eastport
Franklin Manor on the Bay and Cape Anne
Galesville
Rose Haven

***Baltimore City**

Baltimore County
Back River Neck
*Dundalk (Including Sparrows Pt.)
*Middle River Neck
*Patapsco River Neck

Calvert County
Cove Point
North Beach on the Bay
Solomons Island

Caroline County
Choptank
*Denton
Federalsburg

Cecil County
Elkton
Northeast

Charles County
Cobb Island

Dorchester County
*Cambridge

Harford County
Havre de Grace

Kent County
*Rock Hall

Queen Anne's Co.
Dominion
*Grasonville
Stevensville

St. Mary's County
Colton
*Piney Point
St. Clement Shores
St. George Island

Somerset County
*Crisfield
*Smith Island

Talbot County
Easton
Oxford
*St. Michaels
*Tilghman Island

Wicomico County
Bivalve
Nanticoke
*Salisbury

Worcester County
*Pocomoke City
*Snow Hill

COMMONWEALTH OF VIRGINIA

Independent Cities
*Chesapeake
*Fredericksburg
*Hampton
Newport News
*Norfolk
*Portsmouth
*Virginia Beach

Accomack County
Onancock
Saxis
*Tangier Island

King George County
*Dahlgren

King William County
*West Point

***WASHINGTON, D.C.**

Northampton County
*Cape Charles

Westmoreland County
*Colonial Beach

York County
*Poquoson

*Indicates "critically" flood-prone communities.

TABLE B-3

CRITICAL COMMUNITIES RECOMMENDED FOR DETAILED STUDY
(In the Revised Plan of Study)

STATE OF MARYLAND

Baltimore County
Dundalk (including Sparrows Pt.)

Baltimore City

Caroline County
Denton

Dorchester County
Cambridge

Kent County
Rock Hall

Somerset County
Crisfield
Smith Island

Talbot County
St. Michaels
Tilghman Island

Wicomico County
Salisbury

Worcester County
Pocomoke City
Snow Hill

COMMONWEALTH OF VIRGINIA

Independent Cities
Chesapeake
Fredericksburg
Hampton
Norfolk
Portsmouth

Accomack County
Tangier Island

King William County
West Point

Northampton County
Cape Charles

Westmoreland County
Colonial Beach

York County
Poquoson

Last and most significantly, Baltimore City and the Dundalk area of Baltimore County were also eliminated after preliminary damage surveys and an evaluation of several structural and nonstructural measures. These preliminary evaluations indicated that both structural and nonstructural measures that would provide flood protection for the most flood-prone sections of these two areas would have benefit-cost ratios on the order of only 0.1. These evaluations confirmed the findings of the Baltimore District's Baltimore Metropolitan Flood Study.

As a result of this screening process, the communities selected for detailed study were limited to those listed in Table B-4. Because of the areal expanse of the Bay Region, and because of the jurisdictional location of these communities, the Baltimore District, Corps of Engineers requested that the Norfolk District conduct the detailed tidal flooding analyses in the Commonwealth of Virginia while the Baltimore District investigated the Maryland communities. Figure B-2 indicates the general location of these communities along the Bay Estuary.

TABLE B-4

TIDAL FLOOD-PRONE COMMUNITIES EXAMINED

Maryland	Virginia
Cambridge	Cape Charles
Crisfield	Hampton Roads*
Pocomoke City	Poquoson
Rock Hall	West Point
Snow Hill	Tangier Island
St. Michaels	
Tilghman Island	

*The Hampton Roads designation includes the cities of Chesapeake, Hampton, Norfolk, and Portsmouth, Virginia.

PLANS AND PROGRAMS OF OTHERS

FEDERAL FLOOD-RELATED PROGRAMS

Although several programs and plans of others can impact upon the flood plains of the communities, there are three Federal flood-related programs which are Bay-wide in scope and will affect not only the communities examined but also the remainder of the communities along the Bay's shoreline. These programs include the National Flood Insurance Program administered by the Federal Emergency Management Agency (FEMA), the activities of the Federal Office of Coastal Zone Management (OCZM), and the recently developed Coastal Hazards Program administered by the National Ocean Survey (NOS) of the National Oceanic and Atmospheric Administration (NOAA).

NATIONAL FLOOD INSURANCE

The National Flood Insurance Program was created in 1968 to provide flood insurance for existing flood plain development and to reduce flood losses by promoting a wiser use of flood plain land. In December 1973, Congress passed the Flood Disaster Protection Act, greatly expanding the available limits of flood insurance coverage and imposing requirements on property owners and communities. In return for making both technical flood hazard information and subsidized flood insurance available for existing structures, a participating community must agree to regulate new development in the flood plains. Structures which are built in accordance with the agreed-to regulations can also obtain flood insurance because of their reduced exposure to flood losses. The regulations are adopted by the community through a flood plain ordinance. The ordinance requires all new or substantially improved structures in the flood plain to be protected to a flood elevation determined by FEMA. The insurance program itself is administered by the Federal Insurance Administration of FEMA. Prior to the creation of FEMA in 1979, the Federal Insurance Administration was part of the Department of Housing and Urban Development.


BALTIMORE
Patapsco River
WASHINGTON D.C.
Choptank River
Patuxent River
Wicomico River
Potomac River
Pocomoke River
Rappahannock River
York River
James River

COASTAL ZONE MANAGEMENT

The Office of Coastal Zone Management (OCZM), acting through separate state agencies in both Maryland and Virginia, has been charged by the Coastal Zone Management Act of 1972 to develop plans and actions to protect and rationally use the lands and waters of the coastal zone. As it applies to flood related hazards, each state unit has been directed to review and integrate any Federal, state, and local plans into the overall coastal management plan for the state. Grants have been made available for both program planning and the actual implementation of a comprehensive management plan. The law is administered by the Secretary of Commerce, who determines whether Federal approval, when sought by a state, should be given to that state's plan. Responsibility for implementing the Act is delegated to the Commerce Department's National Oceanic and Atmospheric Administration through its Office of Coastal Zone Management.

COASTAL HAZARDS

Also within NOAA, a Coastal Hazards Program has been developed in response to President Carter's 2 August 1979 Environmental Message to Congress. The program is designed to coordinate various Federal grants, basic environmental data, technical information, and local expertise so that each of the localities in the 39 identified coastal regions can develop flood warning and evacuation plans to fit their specific problems and requirements. Four specific tasks are performed under this program: (1) storm surge modeling, (2) preparation of climate data packages, (3) coastal mapping, and (4) program coordination, management and support. Overall responsibility for the Coastal Hazards Program has been assigned to the Director, National Ocean Survey (NOS). The Coastal Hazards Program Office was established within NOS to manage the program and to be the central point for coordination of all NOAA coastal hazards-related programs and for coordination with other Federal and state agencies.

LOCAL PLANS AND ACTIVITIES

All of the communities studied are impacted by each of the aforementioned Federal programs. In addition to these specific flood-related programs, activities planned by various other Federal, state, and local agencies can and do impact upon the flood plain area. The following paragraphs discuss, by community, areas where activities are underway or planned. Among the types of activities investigated were shore erosion, navigation, water quality (water supply and wastewater disposal), solid waste disposal, recreation, and fish and wildlife.

CAMBRIDGE, MARYLAND

Shore Erosion Control

Other then small-scale construction and repair of existing bulkheads there are no known existing or proposed plans or studies being made by others in the interest of shore erosion control for Cambridge.

Flood Control

Other than the previously mentioned studies underway by FEMA and NOAA, there are no known existing or proposed plans or studies being made by others in the interest of flood control for Cambridge.

Navigation

There are no known existing or proposed plans being made by others in the interest of navigation improvements except for the continuing channel maintenance dredging of the Federal navigation project by the Corps of Engineers. A market study of the Cambridge Creek area for further commercial and port-related development has also been completed. Development plans include a waterfront hotel and marina facility which will require some changes in existing channel maintenance procedures, if pursued.

Water Quality

The wastewater treatment facilities in Cambridge have been constructed higher than the 500-year flood and function under this level of flooding. Future plans call for the addition of interceptors and force mains in previously unsewered areas (all outside of the 500-year flood plain).

The water supply system for Cambridge is operated on water obtained from ten deep wells. Currently, the present usage is well within the capacity of the wells and any planned expansion, although not currently programmed, will be easily accommodated.

Solid Waste Disposal

The City of Cambridge has regular trash and garbage collection which transports the refuse to three large landfills that are operated by Dorchester County. There are no known existing or proposed plans for expansion of these areas.

Recreation

Other than the continued use and upkeep associated with the Cambridge Harbor Yacht Club, there are no known existing or proposed plans being made by others in the interest of recreational development within the flood plain of Cambridge. However, the Cambridge Creek redevelopment study may result in some water-related recreational development.

Fish and Wildlife

There are no known existing or proposed plans by others in the interest of either insect control or wetland development within Cambridge.

CRISFIELD, MARYLAND

Shore Erosion Control

Other than small-scale construction and repair of existing bulkheads there are no known existing or proposed plans or studies being made by others in the interest of shore erosion control for Crisfield.

Flood Control

Other than the previously mentioned studies underway by FEMA and NOAA, there are no known existing or proposed plans or studies being made by others in the interest of flood control for Crisfield.

Navigation

A permit was issued to the Maryland Department of Natural Resources (DNR) for the upgrading of the marina facilities at Somer's Cove. The project, now complete, consisted of dredging the shallow portion of the cove to 10 feet, the addition of several piers and boat-launching ramps, and the timber bulkheading of that portion of the cove associated with the new piers. Spoil disposal areas are located in the area but will have a minimum impact on any proposed structural flood protection plans. Regular dredging of the existing Federal navigation project by the Corps of Engineers can also be expected to continue. Lastly, feasibility studies concerning the development of Crisfield as a deepwater port have been proposed on several occasions, but no firm plans have materialized.

Water Quality

The wastewater treatment facility in Crisfield is located within the 100-year flood plain. It can be afforded protection from flooding under the structural plans considered in this study and thus contribute indirectly to the overall efficiency and operation of the system. By preventing storm water infiltration and inflow, the sewage treatment plant could function under flooding conditions and prevent the bypass of untreated sewage to the Little Annemessex River. There are no known existing or proposed plans being made relative to protection of the facility.

The water supply system for Crisfield is operated on water obtained from five deep wells. Currently, the present usage is within the capacity of the wells and any planned expansion, although not currently programmed, will be easily accommodated.

Solid Waste Disposal

The City of Crisfield has regular trash and garbage collection which transports the refuse to landfills operated by the town outside of the study area. There are no known existing or proposed plans for expansion of these areas.

Recreation

Other than the previously mentioned plans associated with the Somer's Cove area, there are no known existing or proposed plans being made by others in the interest of recreational development within the flood plain of Crisfield.

Fish and Wildlife

The vast wetlands near and within the Town of Crisfield are a recognized resource of great natural and economic value. Erosion is taking its toll on wetlands, however, there are no known existing plans to mitigate erosion and thereby reduce the rate of destruction to wildlife habitat. Remedial measures have been taken to stem the erosion, but largely along the shoreline or the roadway fronting individual homes. Remote wetland areas have not received any attention except for the periodic dredge material disposal connected with channel dredging.

It is also recognized that the control of insects is a significant problem in the Crisfield area. Conditions in Crisfield are favorable for insect growth; consequently the mosquito population is large. The state and county governments currently operate mosquito control units which control the problem by daily spraying and the small scale ditching and draining of standing water areas. There are no known existing or proposed plans which will expand these efforts.

POCOMOKE CITY, MARYLAND

Shore Erosion Control

Other than small-scale construction and repair of existing bulkheads there are no known existing or proposed plans or studies being made by others in the interest of shore erosion control for Pocomoke City.

Flood Control

Other than the previously mentioned studies underway by FEMA and NOAA, there are no known existing or proposed plans or studies being made by others in the interest of flood control for Pocomoke City.

Navigation

There are no known existing or proposed plans or studies being made by others in the interest of navigation improvements for Pocomoke City except for the continued channel maintenance dredging of the Federal navigation project by the Corps of Engineers.

Water Quality

The wastewater treatment facilities in Pocomoke City have been constructed above the 500-year flood level and will function under this level of flooding. There are no plans for expansion of the current facilities.

The water supply system for Pocomoke City is operated on water obtained from two deep wells. Currently, the present usage is well within the capacity of the wells and no expansion is planned. An unlimited supply of water for industrial purposes is available from the Pocomoke River.

Solid Waste Disposal

Pocomoke City has regular trash and garbage collection which transports the refuse to landfills outside of the area. There are no known existing or proposed plans for expansion of these areas.

Recreation

In addition to the continued use and upkeep associated with the docks, walkways, bulkheads, and boat launching ramps at Cypress Park, there is a plan for recreational development within the flood plain of Pocomoke City. Pocomoke City instituted a waterfront redevelopment plan in 1981 and has made progress in implementing this plan which will contribute to passive recreational activities.

Fish and Wildlife

There are no known existing or proposed plans or studies being made by others in the interest of either insect control or wetland development in Pocomoke City.

ROCK HALL, MARYLAND

Shore Erosion Control

Other than small-scale construction and repair of existing bulkheads there are no known existing or proposed plans or studies being made by others in the interest of shore erosion control for Rock Hall. As noted in subsequent paragraphs, the modifications of the existing Federal navigation project now provide a measure of shoreline protection for these areas inside the breakwaters.

Flood Control

Other than the previously mentioned studies underway by FEMA and NOAA, there are no known existing or proposed plans or studies being made by others in the interest of flood control for Rock Hall.

Navigation

Modification of the existing navigation project at Rock Hall Harbor was recently completed by the Corps of Engineers. The improvement is expected to increase harbor protection, reduce shoaling, and allow for the expansion of harbor facilities. Included in the completed modification were the raising of the existing breakwaters from 4 feet mean low water (mlw) to 7 feet mlw and the extension of the western breakwater an additional 400 feet; the relocation of the entrance channel to a depth of 8 feet; and the creation of two new channels to a depth of 8 feet. Regular dredging of the Federal channels can also be expected to continue.

Water Quality

The wastewater treatment facilities in Rock Hall have been constructed above the 500-year flood level and will function under this level of flooding.

The water supply system for Rock Hall is operated on water obtained from three deep wells. Currently, the present usage is well within the capacity of the wells and planned expansions in the Sharpe, Liberty, North Main, and Judefind Street areas will be easily accommodated.

Solid Waste Disposal

Rock Hall has regular trash and garbage collection which transports the refuse to county operated landfills outside of the community. There are no known existing or proposed plans for expansion of these areas.

Recreation

Other than the continued use and probable expansion of the recreational boating facilities in the Rock Hall/Gratitude area, there are no known existing or proposed plans by others in the interest of recreational development within the flood plain of Rock Hall.

Fish and Wildlife

The vast wetlands near and within the Town of Rock Hall are a recognized resource of great natural and economic value. Erosion is taking its toll on wetlands, however, there are no known existing official plans to mitigate erosion and thereby reduce the rate of destruction to wildlife habitat. Remedial measures have been taken to stem the erosion, but largely along the shoreline or the roadway fronting individual homes. Remote wetland areas have not received any attention except for the periodic dredge material disposal connected with channel dredging.

SNOW HILL, MARYLAND

Shore Erosion Control

Other than small-scale construction and repair of existing bulkheads there are no known existing or proposed plans or studies being made by others in the interests of shore erosion control for Snow Hill.

Flood Control

Other than the previously mentioned studies underway by FEMA and NOAA, there are no known existing or proposed plans or studies being made by others in the interest of flood control for Snow Hill.

Navigation

There are no known existing or proposed plans or studies being made by others in the interest of navigation improvements for Snow Hill except for the continued channel maintenance dredging of the Federal navigation project by the Corps of Engineers.

Water Quality

The wastewater treatment facility in Snow Hill (located within the 100-year flood plain) can be afforded protection from flooding through structural measures proposed as part of the study. By preventing storm water infiltration and inflow, the sewage treatment plant could function under flooding conditions and prevent the bypass of untreated sewage to the Pocomoke River. However, there are no known existing or proposed plans being made by the Town of Snow Hill in this regard.

The water supply system for Snow Hill is operated on water obtained from two deep wells. Currently, the present usage is well within the capacity of the wells and no expansion is planned.

Solid Waste Disposal

The Town of Snow Hill has regular trash and garbage collection which transports the refuse to landfills outside of the community. There are no known existing or proposed plans for expansion of these areas.

Recreation

In addition to the continued use and upkeep associated with the docks, bulkheads, and boat launching ramps at Byrd Park, there is a plan for recreational development within the flood plain of Snow Hill. Snow Hill prepared a waterfront redevelopment plan in 1981 which will, when completed, contribute to passive recreational activities.

Fish and Wildlife

There are no known existing or proposed plans or studies being made by others in the interest of either insect control or wetland development within Snow Hill.

ST. MICHAELS, MARYLAND

Shore Erosion Control

Other than small-scale construction and repair of existing bulkheads there are no known existing or proposed plans or studies being made by others in the interest of shore erosion for St. Michaels.

Flood Control

Other than the previously mentioned studies underway by FEMA and NOAA, there are no known existing or proposed plans or studies being made by others in the interest of flood control for St. Michaels.

Navigation

There are no known existing or proposed plans or studies being made by others in the interest of navigation improvements for St. Michaels except for the continued channel maintenance dredging of the Federal navigation project by the Corps of Engineers. The Board of Port Wardens for St. Michaels has adopted harbor lines for St. Michaels Harbor. These harbor lines establish limits regarding pier construction and encroachments into the harbor.

Water Quality

The new wastewater treatment facilities in St. Michaels have been constructed above the 500-year flood level and will function under this level of flooding. Future plans call for only the addition of interceptors and force mains in some outlying areas.

The water supply system for St. Michaels is operated on water obtained from deep wells. Currently, the present usage is well within the capacity of the wells and any planned expansion, although not currently programmed, will be easily accommodated.

Solid Waste Disposal

The Town of St. Michaels provides regular trash and garbage collection which transports the refuse to a landfill just east of the Easton area. There are no known existing or proposed plans for expansion of this area.

Recreation

Other than the tourist related activities associated with both the Chesapeake Bay Maritime Museum and the recreational boating in St. Michaels Harbor, there are no known existing or proposed plans being made by others in the interest of recreational development within the flood plain of St. Michaels.

Fish and Wildlife

There are no known existing or proposed plans or studies being made by others in the interest of either insect control or wetland development within St. Michaels.

TILGHMAN ISLAND, MARYLAND

Shore Erosion Control

Other than small-scale construction and repair of existing bulkheads there are no known existing or proposed plans or studies being made by others in the interest of shore erosion control for Tilghman Island. In 1982 a Section 14 Study of an emergency shore erosion problem at Black Walnut Point was conducted by the Corps of Engineers. The erosion threatened to wash out roads and utility lines at the southern tip of Tilghman Island. An erosion control project consisting of 375 feet of revetment was recommended and construction was completed in spring 1984.

Flood Control

Other than the previously mentioned studies underway by FEMA and NOAA, there are no known existing or proposed plans or studies being made by others in the interest of flood control for Tilghman Island.

Navigation

There are no known existing or proposed plans or studies being made by others in the interest of navigation improvements for Tilghman Island except for the continued channel maintenance dredging of the Knapp's Narrows Area by the Corps of Engineers. The Corps navigation study of Tilghman and Nevitt Harbors was recently completed. Improvements to Nevitt Harbor were found to be unjustified while storm protection at Tilghman Harbor was justified and resulted in the construction of a breakwater.

Water Quality

There are no wastewater treatment facilities located in the Tilghman Island area and all sewage is handled by private septic systems. There are no known existing or proposed plans to provide sewer service for the community.

The water supply system for Tilghman is self-supplied by private wells. No water distribution system currently exists and there are no known exisiting or proposed plans or studies being made by others in the interest of water supply.

Solid Waste Disposal

There is no regularly scheduled trash collection service provided for all of the residents on Tilghman Island. Refuse collection can, however, be contracted for through private firms which transport the refuse to a landfill site just east of the Easton area. It is expected that some open dumping will continue to be a means by which Tilghman Island residents dispose of refuse until a program aimed at community-wide refuse collection is initiated.

Recreation

There is no evidence of any effort to provide comprehensive planning for the utilization of existing recreational potential for tourists or local residents on Tilghman Island. However, given the nature of an island fishing community, it can be expected that tourists will continue to visit Tilghman Island to sample, first-hand, elements of the island's natural and social environments.

Fish and Wildlife

The vast wetlands near Tilghman Island are a recognized resource of great natural and economic value. Erosion, however, is taking its toll on these wetlands. There are no known existing official plans to mitigate the erosion and thereby reduce the destruction of wildlife habitat. Remedial measures have been taken to stem the erosion, largely along the shoreline or the roadway fronting individual homes. Remote wetland areas have not received any attention except for the periodic dredge material disposal connected with channel dredging.

CAPE CHARLES, VIRGINIA

Shore Erosion Control

In 1977, a resource conservation and development project was prepared by the U.S. Department of Agriculture, Soil Conservation Service. It was sponsored by Cape Charles, the Northampton County Board of Supervisors, and the Eastern Shore Soil and Water Conservation District. The primary objective of the plan was to protect the existing bulkhead, walkway, state highway, and residences of Cape Charles from adverse storm and/or wave action from Chesapeake Bay. A secondary objective was the stabilization and rehabilitation of the beach area in hopes of eventually constructing a swimming beach and fishing pier at the site.

Elements of this plan have been in place since October 1, 1982. These include removal of all pre-existing groins, installation of nine new groins spaced about 200 feet apart and extending 80 feet bayward from the existing bulkhead, and repairs to damaged portions of an adjacent walkway in order that dangers to health and safety may be alleviated and aesthetics of the beach enhanced. In addition, wind-blown beach sand and saltwater are being intercepted by sand fences on the beach and by vegetated areas that act as wind breakers between the walkway and highway. Unfortunately, however, deposits at the northern end of the bulkhead have not been as great as was hoped for. Plans have been made to install a pipeline running along the east side of Bay Avenue and emptying at sites north and south of the existing bulkhead, but this must await repairs to the system's connector lines leading to the town's secondary sewage treatment plant.

Flood Control

A flood insurance study including the effect of wave action was done for Cape Charles and became effective on 2 February 1983.

Navigation

This office is unaware of any navigation projects being planned, other than those now maintained by the Corps.

Water Quality

Water quality management plans for the Cape Charles service area include servicing Cape Charles and sanitary wastes from a proposed Brown and Root Company industrial facility. Since these plans were developed, however, Brown and Root officials have indicated that plans for establishing their operation in Cape Charles have changed and they do not intend to build in the near future, if at all. What is more, Cape Charles itself has recently constructed its own secondary wastewater treatment plant. This facility, while complete, is not yet fully operational because of surcharges in the system of collector lines during storms and abnormally high tides. As a result, Cape Charles continues to discharge raw sewage into its harbor, thereby adding to fecal coliform bacteria and reducing the levels of dissolved oxygen in these waters. This results in a situation that represents the typical water quality problem associated with the Chesapeake Bay side of the eastern shore -- low dissolved oxygen values, increased nutrient concentrations, and high bacteriological levels.

Fish and Wildlife

This office knows of no plans underway in the interests of fish and wildlife.

HAMPTON ROADS, VIRGINIA

Shore Erosion Control

Coastal beaches are continually shifting in response to tides, waves, and winds and absorb a large amount of the energy transmitted to them. While the sloping beach and beach berm are the outer line of defense to absorb this impact, sand dunes also absorb the considerable energy of storm waves thereby protecting inland areas from erosion and flood damage. Although dunes may erode or even be breached, they gradually rebuild to provide protection against future storms. They also provide sand to replace that carried off by severe storms. Unfortunately, dunes have been levelled for real estate development or reduced in size to obtain a view of the sea. Jetties, bulkheads, groins, and retaining walls have been constructed in an attempt to retain the remaining littoral sand drift. However, portions of the south shore of Chesapeake Bay are eroding and creating problems for residential and commercial property.

Flood Control

The City of Portsmouth has constructed a flood wall to protect its downtown area from tidal flooding. It includes a wall of interlocking sheet piles 3,500 feet long with a crest elevation of 8.5. A number of culverts would automatically close during high water. The

Central Business District in Norfolk is protected by a Federally constructed floodwall which provides protection to a level one foot above the 100-year elevation. A number of bulkheads and/or seawalls have also been constructed in various sections of the Hampton Roads city complex.

The Hampton Roads city complex is included in the Federal Flood Insurance Program administered by FEMA. The Virginia State Board of Housing has amended the Virginia Uniform Statewide Building Code to require future construction or additions to existing construction be built with first floor elevations at or above the 100-year flood level. This office knows of no other plans underway in the interests of flood control.

Areas along the Atlantic Ocean and Chesapeake Bay will be able to receive early warning of major storm surges from computer models being developed by NOAA's National Weather Service. The models are known as Sea, Lake, and Overland Surges from Hurricanes (SLOSH). The computer produces predictions on the height of the storm surge based on other predictions made of the storm's intensity and movement derived from information collected by ships, satellites, and aircraft. Several of the models have already been developed, and one was used when Hurricane Bob threatened the New Orleans area in 1979. Weather forecasters in the area were pleased with the performance of the model in helping them prepare local warnings. A SLOSH model has been prepared for the Chesapeake Bay area. It is hoped that this model will enable a more accurate prediction of the peak stage from hurricanes in the Bay area and, together with other data, establish the time of arrival of the crest.

Navigation

There are three major Federal navigation projects in Hampton Roads. These are the Thimble Shoal, Norfolk Harbor, and Newport News Channels. These projects provide 45-foot deep channels which connect the Hampton Roads Harbor with the Atlantic Ocean. There are also a number of lesser depth channels. Private interests such as coal pier operators, shipbuilding and numerous maritime interests, as well as the U.S. Navy have dredged from the Federally maintained channels to their docks and piers. Dredging has also been done to improve navigation in the vicinity of marinas.

Water Quality

Point sources of water pollution may be defined as those continuous sources which are discharged to a receiving water body via an outfall structure, usually a pipe. Prior to its discharge, the wastewater is ordinarily treated to a specified level. Point sources may be composed of primarily domestic or process wastes or a combination thereof.

Within the Hampton Roads city complex, there are many existing municipal wastewater facilities. Additional facilities are programmed for construction. Practically all of these municipal facilities are owned and operated by the Hampton Roads Sanitation District Commission. Numerous municipal facilities in the area have undergone or are presently undergoing extensive expansion and upgrading construction programs to meet treatment requirements as mandated by the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500). The Hampton Roads Sanitation District Commission is carrying out an aggressive construction program to bring facilities up to the level of secondary treatment. Construction programs are currently in progress to

expand and upgrade existing residual solids disposal facilities. Digestion is the predominant disposal method in the area. The Hampton Roads Sanitation District Commission is presently investigating techniques such as sludge farming and sludge composting as potential methods of disposal.

The area contains many industrial facilities which discharge waste overboard to receiving waters. These discharges consist of process waste, cooling water, wash water, drydock discharges, and storm water runoff from site drainage. Military reservations and operations which discharge overboard to receiving waters are also assigned to this category. In Virginia, the Virginia State Water Control Board has issued National Pollutant Discharge Elimination System (NPDES) permits to industrial dischargers on a case-by-case basis. The majority of industries (excluding Federal facilities) are achieving their current NPDES permit limits for flow, BOD_5 and total suspended solids. Additional parameter limitations such as pH, temperature, and heavy metals are also being developed.

Nonpoint pollution may be defined as pollutants emanating from land activities transported to receiving waters during rainfall events and may be categorized as either discrete or diffuse. Generally, a storm sewer collection system or a defined drainage ditch is associated with the discrete type, whereas a diffuse type may be thought of as sheet runoff and has no collection system or defined point of discharge. Special nonpoint sources may include, but are not limited to, runoff from animal feed lots, solid waste disposal areas, coal piers, dredge disposal areas, large construction areas, large parking lots, and storage areas. In addition to the above special sources, marinas and shipping activity are considered to be special nonpoint sources of water pollution. Attempts have been and are being made to reduce these types of land use conditions, thereby reducing the pollution loading of river systems and the Chesapeake Bay. Water quality problems within the Hampton Roads city complex include high nutrient levels, bacteriological contamination, periodic oil spills, high heavy metals, and chlorinated hydrocarbon concentrations in the sediment and occasional sewage overflows.

Fish and Wildlife

The pesticide Kepone was still evident in fish and sediment of the lower James River in the spring of 1982. As a result, the State Department of Health extended its ban on commercial fishing for certain species. Recreational fishing is unrestricted.

POQUOSON, VIRGINIA

Shore Erosion Control

This office knows of no plans underway pertaining to shore erosion protection. Poquoson is a member of the Peninsula Planning District Commission and has participated actively in Coastal Zone Management.

Flood Control

The city is included in the Federal flood insurance program administered by FEMA. The Virginia State Board of Housing has amended the Virginia Uniform Statewide Building Code to require that future residential construction be built with first floor elevations at or above the 100-year flood level. This office knows of no other plans underway in the interest of flood control other than that referred to in the section on Water Quality.

Navigation

Canals have been dredged in the more affluent section of Poquoson to permit recreational craft that traverse Chesapeake Bay to be located adjacent to the owner's home.

Water Quality

The Poquoson River is a small sub-estuary of Chesapeake Bay located between the York and James Rivers. The basin lies primarily in York County and the City of Poquoson. Land uses are largely rural in nature and pollution loadings to the receiving stream are due primarily to nonpoint runoff.

The Poquoson River is branched and shallow and receives no continuous input of freshwater because water supply reservoirs have been built in the headwaters. The water column is well mixed as basin flushing is tidally driven. The mean tidal range is 2.4 feet.

There are four small branches that have been condemned for shellfish harvesting. The areas include portions of Chisman, Patrick, Lambs and Bennett Creeks. Bennett Creek is a part of the City of Poquoson. Assuming there will be no point discharges, water quality in Poquoson River will remain good in dry weather, but may deteriorate in wet weather without additional controls.

Back River is also a small sub-estuary of Chesapeake Bay. Its drainage basin includes much of the cities of Poquoson, Hampton, and a small portion of Newport News. The majority of the land use types are rural in nature.

The river has little continuous freshwater flow and circulation depends on tidal influences. Consequently, the capacity of the river to assimilate wastes is not great. The water quality during dry weather will remain good. However, major rainstorms will cause temporary increases in nutrients, phytoplankton, and coliforms. Proposed controls will protect the basin from point source discharge problems. Additional testing is needed to develop more effective controls for nonpoint nutrient loadings.

The City of Poquoson is completing a HUD grant to improve the Trinity area. The construction provided for in this grant has been completed. The Trinity area is the most blighted and economically depressed area of the city. It includes Ridge Road, Bay Street, Messick Road, Freeman Drive, and a portion of Poquoson Avenue. The area has the most severe and greatest concentration of substandard housing in the city. The grant accomplished the following items:

a. Installation of 8,000 feet of gravity sewer lines, 500 feet of force mains, and 600 feet of lateral sewer connection lines,

b. Installation of 20,000 feet of drainage conduits to eliminate potential flooding of project areas and mosquito breeding sites,

c. Loans and grants for 231 homes to connect to sewer line extensions and to rehabilitate homes,

d. Installation of recreational equipment in a park.

Tidal marshes of considerable extent are located adjacent to and within Poquoson. Several techniques are available to control commercial and/or residential growth in these areas including flood plain zoning, shoreline regulations, and environmental review. Wetlands zoning ordinances are already in effect consistent with guidelines established by the Virginia Marine Resources Commission. Zoning ordinances already contain provisions for site plan review which can give special consideration to environmental factors.

Fish and Wildlife

This office knows of no plans underway in the interest of fish and wildlife.

TANGIER ISLAND, VIRGINIA

Shore Erosion Control

The erosion rate is critical along the inhabited western shore of Tangier Island. According to the Virginia Institute of Marine Science, comparison between the 1942 and 1968 editions of the U.S. Geological Survey quadrangles gives an average rate of loss of 13 feet per year. Comparison of the 1968 quadrangle with recent VIMS aerial photographs indicates that present erosion in the vicinity of the airstrip is approximately 27 feet per year. Portions of the airstrip and residences on West Ridge are in considerable jeopardy if adequate measures are not taken to stem the erosion.

The Corps has begun to place material, resulting from maintenance dredging of the two Federal navigation channels, along the western shore. This practice, especially the removal of sand from the channel between Chesapeake Bay and Tangier, should be continued. However, this will not resolve the erosion problem.

Plans for a low wall along the western edge of the island have been prepared and are awaiting funds—Federal, state, and/or private — for its construction. This would deter the erosion problem. The cost is estimated at several million dollars.

Flood Control

A flood insurance study was conducted and released in October 1982. The study takes into account wave action and is based on a VIMS stillwater elevation for the 100-year flood of 4.1 feet. A topographic map was prepared for the island and shows the three inhabited ridges of the island to be below elevation 5 feet.

Navigation

This office is unaware of any navigation projects being planned, other than those now maintained by the Corps.

Water Quality

According to the Water Quality Inventory (305b Report, 1982),

> The principal water quality problem in the vicinity of Tangier Island is high bacteriological counts which not only exceed Water Quality Standards but also provide a threat to the health of the citizens. Due to the extremely high water table, septic tank leachate in ground and/or surface waters is a primary pollution source. Also, contamination of State waters via general surface runoff is a major concern due to the Island's large domestic animal population, utilization of surface privies, and the present mode of solid waste disposal ....
>
> Heavy boating activity in the vicinity of Tangier Island contributes to a persistent oil sheen on many of the inlets and all harbor areas. Portions of this segment do not meet Water Quality Standards or 305(b)(1)(B) criteria due to violation of bacteriological standards and low dissolved oxygen levels.

The projected sanitary flow for Tangier in the year 2000 is 0.12 mgd. A new wastewater treatment plant and collection system was scheduled to become operational in late 1983. This system would service the entire town. The plant will have a capacity of 0.1 mgd and could be enlarged in the future if the need arises. This system should be sufficient for the foreseeable future since little or no growth is expected in Tangier. This new system should help to improve the water quality in and around Tangier. The discharge of the plant is into Chesapeake Bay.

Fish and Wildlife

This office knows of no plans underway in the interests of fish and wildlife.

WEST POINT, VIRGINIA

Shore Erosion Control

This office is unaware of any plans underway at West Point concerning shore erosion.

Flood Control

The Chesapeake Corporation has a plan underway to raise all machinery and equipment to or above elevation eight. Shoreline reinforcement by concrete and riprap extends along some property into the Mattaponi River. There are also bulkheads along the York River. The status of West Point for purposes of participation in the National Flood Insurance Program is emergency. This means that there is a program in effect to provide a first layer amount of insurance on all insurable structures before the effective date of the initial Flood Insurance Rate Map.

Navigation

There are piers and docking facilities scattered around the shoreline plus an extensive bulkheaded docking facility for The Chesapeake Corporation. There has also been some discussion of deepening the existing channel and extending it further upstream to terminate in a new turning basin.

Water Quality

Both the town and The Chesapeake Corporation operate secondary sewage treatment systems. In accordance with Section 201 of Public Law 92-500, a Federally financed plan of the town's system is under study, but has not been submitted for either state or EPA approval.

Fish and Wildlife

This office knows of no plans underway concerning fish and wildlife.

MANAGEMENT MEASURES

As required by the Principles and Standards, consideration was given to both structural and nonstructural protection measures as a means of solving flood-related problems. In an effort to identify potential measures which could address one or more of the specific planning objectives, a broad range of measures was identified during development of the Plan of Study and early in Stage II. Most of the measures were carried forward in the Stage II planning.

The following sections discuss those management measures which were investigated in detail. Several of the measures presented were quickly eliminated based on engineering and/or economic criteria and are so noted. Further discussion of these structural and nonstructural measures can be found in Appendix E - Engineering Design and Cost Estimates.

LEVEES AND FLOODWALLS

Levees and floodwalls, while differing in design, appearance and cost, serve essentially the same purpose. Both are constructed near the shoreline to protect landside development from inundation by tidal floodwaters. A substantial reduction in both nuisance and major tidal flooding problems can be realized with these structural measures. The levees under consideration are earth embankments having a top width of approximately 10 feet and side slopes of 1 on 3. The waterside face of the levee is armored with stone where appropriate to prevent wave damage. Levees are generally less expensive than floodwalls and are particularly applicable where construction materials are available and there is sufficient area between the shoreline and the area to be protected. Floodwalls are generally concrete with vertical faces and, because of their cost, are used in areas where close proximity of the development precludes the construction of levees.

SEAWALLS, BULKHEADS, AND REVETMENTS

Seawalls, bulkheads, and revetments are structures placed parallel to the shoreline to separate a land area from a water area. These structures serve to both retain the land behind them and provide protection from wave damage. These structures are generally used where it is necessary to maintain the shore in an advanced position relative to that of adjacent shores, where there is little or no protective beach or where it is desired to maintain a certain depth of water along the shoreline.

OTHER STRUCTURAL MEASURES

Other types of structural measures that can be employed along coastal areas to provide protection from tidal flooding include sand dunes and breakwaters. Dunes along the coast can prevent the movement of storm tides and waves into the area behind the beach. Breakwaters can serve to provide protection from waves thus creating harbors of refuge and protection for harbor facilities. Given both the nature of the tidal flooding and the communities under study, further consideration was not given to these two measures.

FLOODPROOFING

Floodproofing is a combination of structural changes and adjustments to structures and building contents which are designed to reduce flood damages. Although it is more simply and economically incorporated into new construction, floodproofing is also applicable to existing structures that are structurally sound. An inventory of the communities revealed that most residential and some older commercial buildings that may require floodproofing were of metal or wood frame construction and therefore not able to withstand the hydrostatic forces. Conversely, several of the new commercial buildings constructed of concrete block were capable of incorporating floodproofing measures rather easily. Therefore, consideration was given to only basement floodproofing of residential structures and commercial floodproofing of structurally sound structures. Basement floodproofing consists of raising the superstructure of residential structures, removal of the existing foundation including basement walls, construction of a new reinforced concrete substructure with waterstops, provision of check valves in the storm and sanitary lines, and landscaping. Commercial floodproofing includes the floodproofing of the first floor and/or basement by provision of a floodwall, flood shields, waterproofing compounds, back flow valves and sump pumps.

RAISING

This alternative consists of raising the elevation of the basement and/or first floor of a damage-prone structure. Depending on the type of structure, foundation composition, and height of raising, various measures may have to be employed. These measures may include such items as physically raising the superstructure, provision of a new foundation and basement walls, utility additions, and landscaping.

UTILITY ROOM ADDITION

This alternative consists of relocating all basement utilities to a wood-frame utility room constructed adjacent to the home at the first floor level. This addition reduces part of

the damages in the basement by moving those utilities subject to damage to a less frequently flooded location.

RELOCATION

Relocation of a structure to a non-flood plain site involves physically moving the structure a reasonable distance to a prepared flood-free site of comparable value. The costs of house relocation have been developed on the premise that the Corps will administer all the necessary contracts to include moving the superstructure, razing the abandoned site, preparation of a new site, and modifying the house as necessary to accommodate the move.

ACQUISITION AND DEMOLITION

Acquisition and demolition includes relocation of the homeowner, the purchase of a particular structure at a fair and reasonable price, demolition of the structure and restoration of the site by filling, grading and seeding where required. It should be noted that the estimates developed for this alternative include an allowance for costs associated with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970.

FLOOD WARNING AND EVACUATION

Early in the Study, a flood warning and evacuation plan was identified as a potential tidal flood control alternative. Hurricane tidal-flood damages can be reduced by the provision of improved forecasting and warning services, and the establishment of evacuation plans. A hurricane warning system, combined with emergency mobilization, would aid in the prevention of loss of life and of damage to items which are readily movable, but would not prevent the actual flooding of properties. Further study revealed that the National Weather Service has a "self-help" program for coordinating and developing flood warning systems in conjunction with local governments. In addition it was found that the National Ocean Survey has received the authority to study, in detail, flood warning and evacuation along the coastal regions of the United States under the NOAA Coastal Hazards Program. Accordingly, detailed investigation of flood warning and evacuation plans was not deemed appropriate.

FLOOD INSURANCE

Although flood insurance does not reduce flood damages, it does provide some compensation for flood damages which have been suffered. All the communities under study in the Bay area became eligible for flood insurance in 1974 under either the regular or the emergency programs authorized by the Flood Disaster Protection Act of 1973 and administered by FEMA. Residents of the communities may purchase flood insurance under this program and accordingly, there was no need to investigate this measure.

NO ACTION

One nonstructural option that must obviously be considered is "No Action." There will be numerous flood-prone structures that, because of their structural condition, level and frequency of expected flooding or other factors, will not be recommended for any type of structural or nonstructural flood protection.

ANALYSIS OF PLANS CONSIDERED

The following sections provide, by community, an analysis of all plans considered during the study. Included is a general overview of the criteria used in developing the plans as well as descriptions of the plans of improvements. A discussion of impact assessment and evaluation is provided along with sensitivity analyses which examined the effects of varied stage-frequency assumptions on plan formulation. Summary tables are also included to provide comparative assessments and evaluations of all plans considered for each of the communities.

As a result of the 1980 analyses, several of the community flood control plans were identified as meriting further study. The communities that were identified for further examination are located in Virginia and include Cape Charles, Hampton Roads, Poquoson, Tangier Island, and West Point. These communities were re-examined in the summer and fall of 1983 by the Norfolk District, Corps of Engineers to determine if the earlier analyses were still appropriate, if additional development had taken place in the flood-prone areas, and if detailed study of the problem and solutions was warranted. The plans developed for the Maryland communities were not examined further because the economic rationale necessary for further evaluation was not sufficient. However, field visits were made to each of the Maryland communities to determine if any recent development in the flood-prone areas was substantial enough to alter the 1980 findings. While development had occurred in some areas, it had little or no impact on the findings. Consequently, the presentation of the plan descriptions and benefit-cost ratios for the Maryland communities were not adjusted. However, the discussions of the Virginia communities do reflect current conditions and findings resulting from the 1983 examinations. For additional information on the development of these plans, refer to Appendix E - Engineering Design and Cost Estimates and Appendix F - Economics.

PLAN FORMULATION RATIONALE

The analysis of plans considered in preliminary planning was based primarily on technical and economic criteria to facilitate early identification of those plans which were not justified. Subsequent plan formulation was based on technical, economic, and intangible criteria, including beneficial and detrimental effects on the environment. These criteria permitted the development of plans of improvement which represented the best response to the stated planning objectives.

TECHNICAL CRITERIA

The following technical criteria were adopted for use in formulating the plans considered in those communities under study.

1. Flood protection should be designed to provide protection against the 100-year tidal flood (approximately equal to the flood of record) and up to the 500-year tidal flood, if practicable.

2. Flood protection design criteria, such as freeboard requirements and design features should be compatible with the existing site conditions, available materials and the type of structure selected.

3. The plans developed should be engineeringly feasible.

ECONOMIC CRITERIA

The economic criteria which were applied in the plan formulation studies included the following:

1. Tangible and intangible benefits should exceed costs.

2. Benefits and costs should be expressed in comparable quantitative economic terms based on either a 50- or 100-year project life and the appropriate Federal interest rate of 7-1/8 percent (FY 1980) or 7-7/8 percent (FY 1983).

3. Interest during construction was not included in the economic analysis because it was either not applicable or it would not effect the economic feasibility of a plan.

ENVIRONMENTAL AND SOCIAL WELL-BEING CRITERIA

Environmental and social well-being criteria considered in the plan formulation process included the following:

1. Loss of life and property and hazards to health and safety should be eliminated.

2. Archeological, historical, aesthetic, geological and ecological resources should be preserved, maintained or enhanced.

3. Community cohesion and desirable community growth should be preserved, maintained or enhanced.

CAMBRIDGE, MARYLAND

DESCRIPTION OF PLANS

Plan CA-1

This plan would consist of an earthen levee 3,430 feet long and a reinforced concrete floodwall 12,050 feet long with a top height of nine feet above NGVD. The combination of levee and wall would protect the entire study portion of the community against the 120-year flood occurrence (6 feet NGVD). The alignment is shown in Figure B-3, reference points A-D. The general location of the following plans are also indicated in Figure B-3 with appropriate references.

Plan CA-2

This plan would consist of a concrete floodwall 9,790 feet long and an earthen levee 1,610 feet long (top height of 9 feet NGVD) protecting the area behind the boat basin and bordering Cambridge Creek (reference pt. B-D). The protection provided by this plan would be for the 120-year flood occurrence (6 feet NGVD).

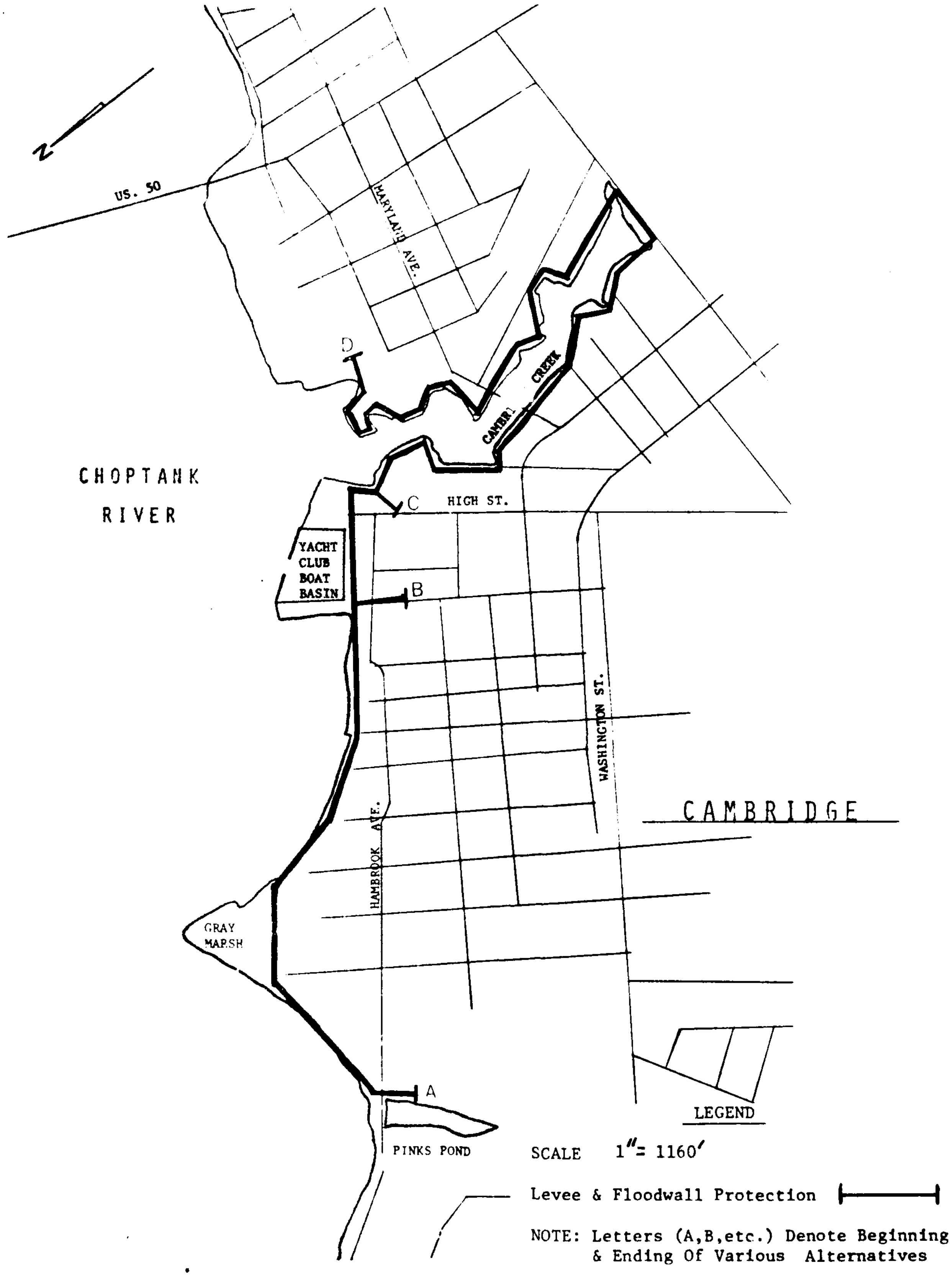


FIGURE B-? PLAN LOCATION OF STRUCTURAL MEASURES FOR CAMBRIDGE, MARYLAND

Plan CA-3

Beginning at reference point C and ending at reference point D, this plan would protect the area around Cambridge Creek against the 120-year flood (6 feet NGVD). It would consist of a concrete floodwall 9,600 feet long and an earthen levee 120 feet long. The top of protection for this area would be 9 feet above NGVD.

Plan CA-4

This plan would be the same as CA-1 in location, but would protect the study area against the standard project flood (8 feet NGVD). The levee would be 3,545 feet long and the floodwall would be 12,080 feet long, with a top elevation of 11 feet. Adding extra length is necessary in order to tie out the structures at the 11 feet ground contours.

Plan CA-5

Similar to Plan CA-2, protection would be provided against the standard project flood (8 feet NGVD). With a top elevation at 11 feet NGVD the levee would be 1,720 feet in length and the concrete floodwall would be 9,820 feet.

Plan CA-6

This plan provides the same protection as CA-3, but to the 8-foot NGVD flood elevation (standard project flood). The earthen levee would have a top elevation of 11 feet NGVD and the floodwall would have the same elevation with lengths of 210 feet and 9,630 feet, respectively.

Plan CA-7

This plan would consist of providing utility additions to five residential structures, flood proofing nine commercial structures and placing concrete/floodwalls around two other commercial structures. The total length of the walls would be 470 feet. This protection plan is designed for the 40-year flood occurrence (5 feet NGVD). All other structures in the study area have first floors at or above this flood height.

Plan CA-8

In this plan seven residential units would receive utility additions and four units would be acquired and demolished. The commercial protection would consist of 10 structures being floodproofed and placing 1,110 linear feet of floodwall around five other structures. The remaining structures have first floors at or above this plan's protection from the 120-year flood (6 feet NGVD).

IMPACT ASSESSMENT AND EVALUATION

Plans CA-1 through CA-6

The floodwall/levee plans investigated would, depending on the plan, provide flood protection for the low-lying areas of the City of Cambridge and protect against storms with approximate return intervals of 120 years to the standard project flood events. In general, levee sections were selected when there was sufficient area between the

shoreline and development for their construction and floodwalls were chosen for restricted space areas or where significant wave attack was expected. Design parameters, approximate costs, typical section, and all assumptions made concerning both floodwalls and levees have been provided in Appendix E—Engineering Design and Cost Estimates.

If the structural plans for Cambridge were implemented, use of the shoreline would be severely restricted and modifications would have to be made to provide access to the existing wharves and piers. During design, consideration must also be given to providing a means of removing water draining into the landside area of the protection. Generally, either a ponding area and/or a pumping station would be provided to avoid flooding from the interior drainage, and many closure structures would be required for local roadway crossings. Construction impacts associated with the building of plans with floodwalls and levees in Cambridge will include noise pollution, destruction of benthic organisms, turbidity and siltation, destruction of small amounts of adjacent wetlands, the creation of dust, and adverse effects to the aesthetic conditions of the area.

Plans CA-1, CA-2, and CA-3 all provide design protection against a tidal flood of 6 feet above NGVD (approximately a 120-year occurrence). Flood control benefits depend on the level, not the method of protection. Accordingly, average annual benefits (AAB) for Plan CA-1 would be approximately $85,000; for Plan CA-2, $66,000; and for Plan CA-3, $57,000 (Appendix F - Economics). Plans CA-4, CA-5, and CA-6 provide design protection against a tidal flood of eight feet above NGVD (standard project flood). Plan CA-4 provides AAB of approximately $104,000; Plan CA-5, $79,000; and Plan CA-6, $67,000. Benefits are based on reductions in flood damages to existing structures as well as labor employed during the construction period.

Plans CA-7 and CA-8

The nonstructural plans investigated for Cambridge consist of combinations of the various nonstructural management measures described earlier. Plan CA-7 would reduce the flood hazard experienced by the community by protecting to the level of the 40-year flood (5 feet above NGVD). Plan CA-8 would protect to the level of the 120-year flood (6 feet NGVD). All costs, design parameters, typical installations, and assumptions regarding the applicability of each of the alternatives are provided in Appendix E - Engineering Design and Cost Estimates.

The nonstructural plans for Cambridge would not have a significant impact on the environment. Minor disturbances such as noise, the potential creation of dust and disruption of the aesthetic conditions would be short-term and localized. The relocation and acquisition and demolition of some structures may create new open areas for wildlife or recreation, but would have some social impact on those whose life styles would be interrupted by relocation.

The AAB for Plan CA-7, 5 feet NGVD protection, is $14,000 while the AAB for Plan CA-8, six feet NGVD protection, is $20,000. Benefits were based on the reduction in flood damages as well as those attributable to employment during construction (Appendix F - Economics).

CRISFIELD, MARYLAND

DESCRIPTION OF PLANS

Plan CR-1

This plan would consist of 15,340 linear feet of earthen levee and 7,280 feet of reinforced concrete floodwall with a top elevation of 8 feet NGVD. Designed for the 80-year flood level (5 feet NGVD) the entire study area would be protected. The alignment is shown in Figure B-4, reference points A-C. The general location of the following plans are also shown in Figure B-4 with appropriate references.

Plan CR-2

This plan would provide protection for the same area as CR-1 except the degree of protection would be for the 6-foot NGVD flood height (400-year return interval). The levee and floodwall would have a top height of 9 feet NGVD and lengths of 16,055 feet and 7,280 feet, respectively (reference points A-C).

Plan CR-3

This plan consists of 14,820 feet of levee together with 6,110 feet of floodwall at a top height of eight feet NGVD. The portion of Crisfield that would not be protected is the Jacksonville area (reference points A-B). The design level of protection would be 5 feet NGVD which is the 80-year event.

Plan CR-4

This plan is the same as Plan CR-3 with the exception of a greater degree of protection — to the 400-year design flood height (6 feet NGVD). There will be 15,535 feet of levee and 6,110 feet of floodwall.

Plan CR-5

This plan would consist of providing a utility addition for one residential structure, relocating three structures, and acquiring one more for demolition. As for commercial structures, two would be acquired and demolished, two would be raised 2'-8", 12 would be floodproofed, and seven would have floodwalls. This plan is designed for the 12-year flood occurrence of 4 feet NGVD. All other structures in the study area have first floors at or above this level.

Plan CR-6

In this plan 24 residential structures would receive utility additions, 20 would be acquired and demolished, and 17 trailers would be relocated. The commercial protection would consist of 41 structures acquired and demolished, 6 structures raised 1'-4", 36 floodwalls, and 61 floodproofings. The remaining structures have first floors at or above this plan's protection against the 80-year flood of 5 feet NGVD.

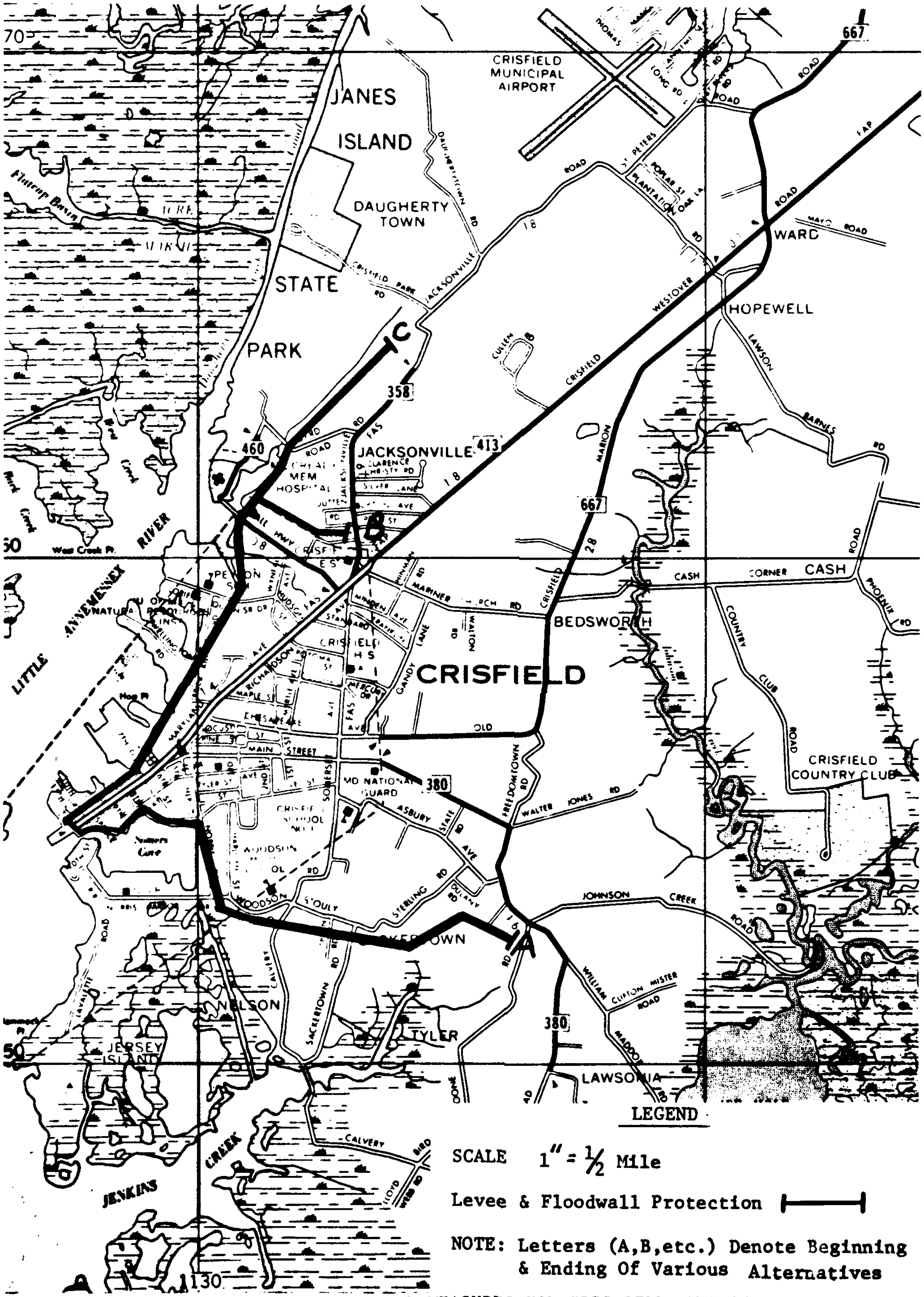


FIGURE B-4 PLAN LOCATION OF STRUCTURAL MEASURES FOR CRISFIELD, MARYLAND

IMPACT ASSESSMENT AND EVALUATION

Plans CR-1 through CR-4

The floodwall/levee plans investigated would, depending on the plan, provide protection for the Town of Crisfield and protect against storms with approximate return intervals from 80 to 400 years. In general, levee sections were selected where there was sufficient area between the shoreline and development for their construction and floodwalls were chosen for restricted space areas or where significant wave attack was expected. Design parameters, approximate costs, typical sections, and all assumptions made concerning both floodwalls and levees are provided in Appendix E - Engineering Design and Cost Estimates.

The construction impacts associated with the building of floodwall/levee plans in Crisfield would be essentially the same as Plans CA-1 through CA-6 in Cambridge. However, a more substantial amount of wetlands and fringe marshes would be destroyed during construction.

Plans CR-1 and CR-3 both would provide design protection against a tidal flood of 5 feet above NGVD (approximately an 80-year occurrence). Flood control benefits depend on the level, not the method, of protection. Accordingly, average annual benefits (AAB) for Plan CR-1 would be approximately $146,000 and for Plan CR-3, $128,000 (reference Appendix F - Economics). Plans CR-2 and CR-4 would provide design protection against a tidal flood of 6 feet above NGVD (approximately a 400-year occurrence). Plan CR-2 would provide AAB of approximately $172,000 and Plan CR-4, $164,000. Benefits are based on reductions in flood damages to existing structures as well as labor employed during construction and the affluence factor.

Plans CR-5 and CR-6

The nonstructural plans investigated for Crisfield consist of combinations of the various nonstructural management measures described earlier. Plan CR-5 would reduce the flood hazard now being experienced by the community and protect to the level of the 12-year flood (4 feet above NGVD). Plan CR-6 would protect to the level of the 80-year flood (5 feet NGVD). All costs, design parameters, typical installations, and assumptions regarding the applicability of each of the alternatives are provided in Appendix E - Engineering Design and Cost Estimates.

The nonstructural plans for Crisfield would not have a significant impact on the environment. Minor disturbances such as noise, the potential creation of dust and disruption of the aesthetic conditions would be short-term and localized. The relocation and acquisition and demolition of some structures may create new open areas for wildlife or recreation, but would have some social impact on those whose life styles were interrupted by relocation. Construction of small floodwalls may result in the adverse effects associated with structural alternatives, although to a much smaller degree.

The AAB for Plan CR-5, 4 feet NGVD protection, is $33,000 while the AAB for Plan CR-6, 5 feet NGVD protection, is $159,000. Benefits are based on the reduction in flood damages as well as labor employed during construction and the affluence factor (reference Appendix F - Economics).

POCOMOKE CITY, MARYLAND

DESCRIPTION OF PLANS

Plan PC-1

This plan would consist of 5,630 linear feet of reinforced concrete floodwall and 4,560 feet of earthen levee with a design elevation of 6 feet NGVD (top elevation of 9 feet NGVD). This wall and levee combination would protect the study portion of Pocomoke City to the 70-year flood return interval as shown in Figure B-5, reference points A-B. The general location of the following protection plans for Pocomoke City are also indicated in Figure B-5 with appropriate references.

Plan PC-2

This plan would provide the same areal protection as PC-1, but to the design elevation of 8 feet NGVD (standard project flood). The protection would consist of 4,870 feet of levee and 5,630 feet of floodwall with a top elevation of 11 feet NGVD (reference points A-B).

Plan PC-3

This plan would consist of providing utility additions to three residential units and acquiring for demolition one other unit. Floodwalls would be placed around two commercial structures while one would be demolished. This plan would provide protection against the 25-year flood (5 feet NGVD). The remaining structures in the study area have first floor elevations at or above this flood level.

Plan PC-4

This plan would provide protection against the 70-year flood height of 6 feet NGVD. Seven residential units would receive utility additions, one structure would be raised 1'-4", two would be acquired and demolished, and one trailer-type would be relocated. Protecting the commercial establishments below this flood height would consist of floodproofing two structures, acquiring one for demolition, and constructing three floodwalls.

Plan PC-5

This plan, would protect against the 220-year flood, 7 feet NGVD, and would consist of providing utility additions to 16 units (residential), raising five units 1'-4" and one - unit 2'-8", relocating one trailer, and acquiring six units for demolition. Commercial protection would consist of acquiring and demolishing two structures, raising one to a height of 1'-4", floodproofing five structures, and placing floodwalls around three more.

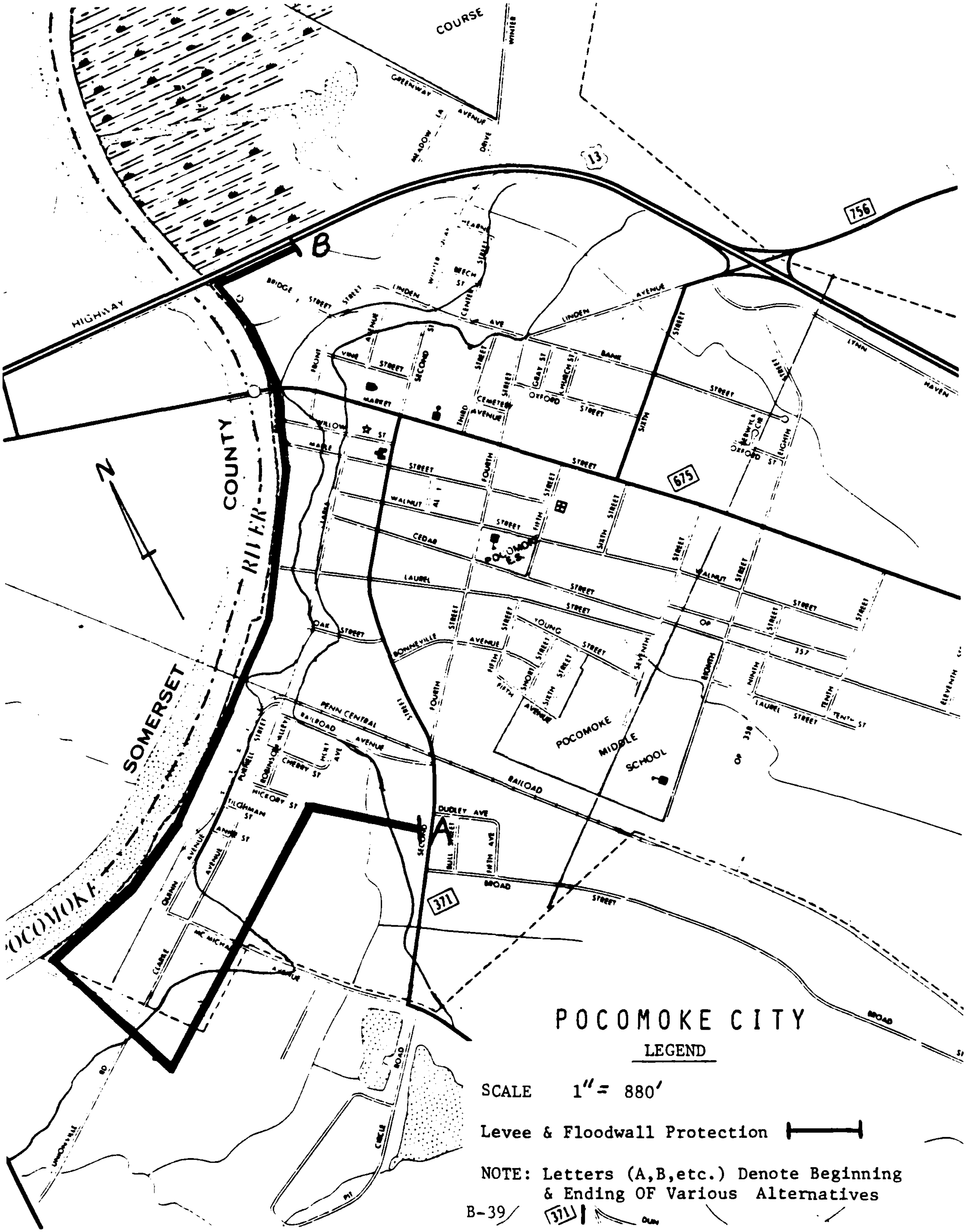


FIGURE B-5 PLAN LOCATION OF STRUCTURAL MEASURES FOR POCOMOKE CITY, MARYLAND

IMPACT ASSESSMENT AND EVALUATION

Plans PC-1 and PC-2

The floodwall/levee plans investigated would, depending on the plan, provide flood protection for the low-lying areas of Pocomoke City and protect against storms with approximate return intervals from 70 years to the standard project flood. In general, levee sections were selected where there was sufficient area between the shoreline and development for their construction and floodwalls were chosen for restricted space areas or where significant wave attack was expected. Design parameters, approximate costs, typical sections, and all assumptions made concerning both floodwalls and levees are provided in Appendix E - Engineering Design and Cost Estimates.

The construction impacts associated with the building of floodwall/levee plans in Pocomoke City would be essentially the same as Plans CA-1 through CA-6 in Cambridge. However, a more significant social impact would be felt relative to the aesthetic conditions, especially in the Cypress Park area.

Plan PC-1 would provide design protection against a tidal flood of 6 feet above NGVD (approximately a 70-year occurrence). Flood control benefits depend on the level, not the method of protection. Accordingly, average annual benefits (AAB) for Plan PC-1 would be approximately $11,000. Plan PC-2 would provide design protection against a tidal flood of 8 feet above NGVD (standard project flood). Plan PC-2 would provide AAB of approximately $17,000. Benefits are based entirely on reductions in flood damages to existing structures (reference Appendix F - Economics).

Plans PC-3 through PC-5

The nonstructural plans investigated for Pocomoke City consist of combinations of the various nonstructural management measures described earlier. Plan PC-3 would reduce the flood hazard experienced by the community and protect to the level of the 25-year flood (5 feet above NGVD). Plans PC-4 and PC-5 would protect to the levels of the 70-year (6 feet NGVD) and 220-year (7 feet NGVD) floods, respectively. All costs, design parameters, typical installations, and assumptions regarding the applicability of each of the alternatives are provided in Appendix E - Engineering Design and Cost Estimates.

The nonstructural plans for Pocomoke City would not have a significant impact on the environment. Minor disturbances such as noise, the potential creation of dust and disruption of the aesthetic conditions would be short-term and localized. The relocation and acquisition and demolition of some structures may create new open areas for wildlife or recreation, but would have some social impact on those whose life styles would be interrupted by relocation.

The AAB for Plan PC-3, 5 feet NGVD protection, is $10,000 while the AAB for Plans PC-4 and PC-5, 6 and 7 feet NGVD protection, respectively, are $13,000 and $18,000. Benefits are based entirely on the reduction in flood damages to those structures receiving nonstructural protection (reference Appendix F - Economics).

ROCK HALL, MARYLAND

DESCRIPTION OF PLANS

Plan RH-1

This plan would consist of 12,840 feet of earthen levee and 9,575 feet of reinforced concrete floodwall (top height of 12 feet NGVD). This would protect the entire study area against the 140-year flood occurrence (9 feet NGVD) as shown in Figure B-6, reference points A through E. The general location of the following plans are also indicated in Figure B-6 with appropriate references.

Plan RH-2

This plan protects the same area as Plan RH-1 but to the standard project flood stage of 12 feet NGVD. There would be 15,940 feet of levee and 9,575 feet of floodwall at a top height of 15 feet NGVD (reference points A-G). Section F-G is added to protect against flooding from Gray's Inn Creek.

Plan RH-3

This plan would protect the Gratitude Section only against the 140-year flood (nine feet NGVD). The levee would be 8,660 feet long and the floodwall 7,370 feet long with a top elevation of 12 feet NGVD. Reference points B-C-D show the alignment.

Plan RH-4

This plan is identical to plan RH-3 (reference points B-C-D) with the exception that the levee and wall would be constructed with 15 feet NGVD as the top of protection. The plan is designed to protect against a 12-foot NGVD flood height (standard project flood).

Plan RH-5

Beginning at reference point A and ending at reference point E (A-B-D-E) this plan is designed to protect the Rock Hall section against the 140-year return interval flood (9 feet NGVD). There would be 7,700 feet of levee and 2,205 feet of floodwall to a top elevation of 12 feet NGVD.

Plan RH-6

This plan would protect the same area as Plan RH-5. Extra levee length would be added (reference point F-G) to bring the protection level up to the design height of 12 feet NGVD (standard project flood). The top of protection would be at 15 feet NGVD. Section F-G is again necessary to prevent flooding from Gray's Inn Creek.

Plan RH-7

The nonstructural residential protection for this plan would consist of one utility addition, six trailer relocations, and four acquisitions and demolitions. For the commercial protection there would be one relocation, six floodproofings, and ten floodwalls. The remaining structures in the study area have first floor levels at or above the design height of 5 feet NGVD (15-year flood return interval).

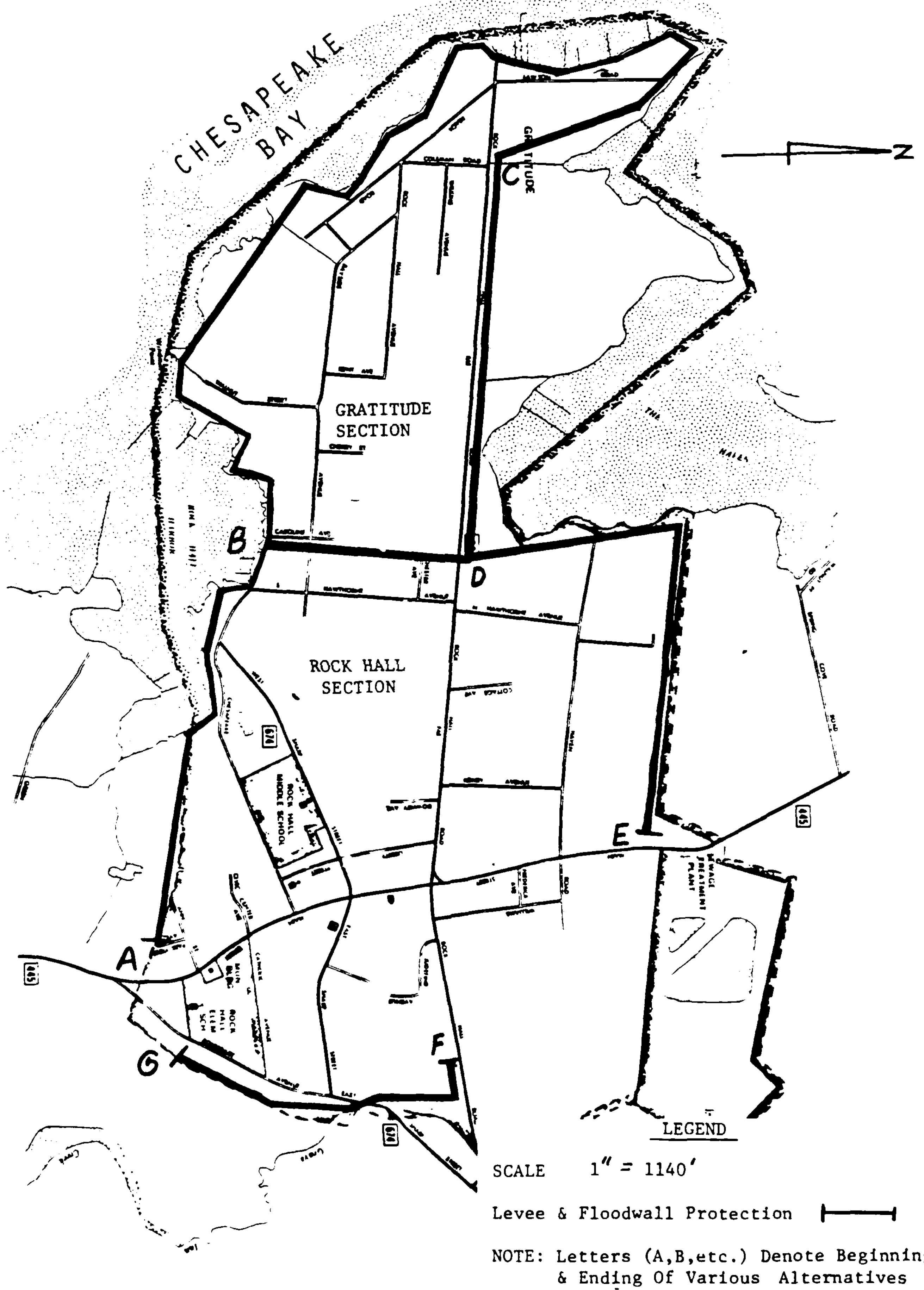
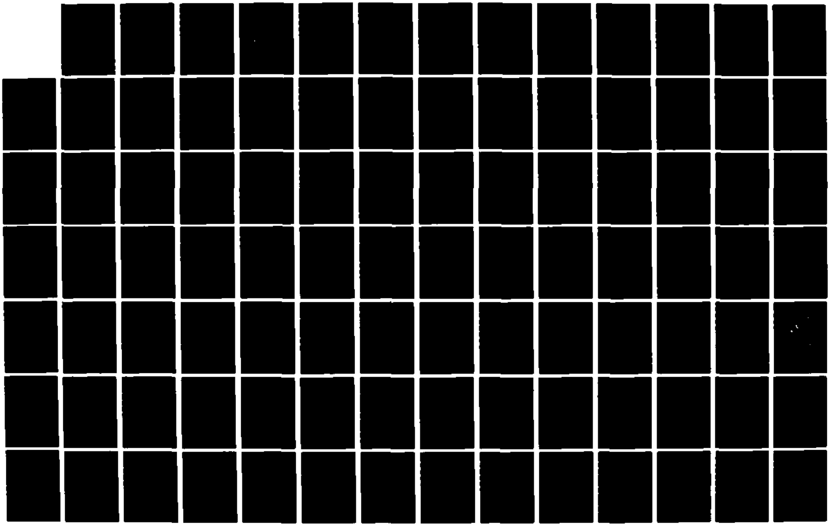
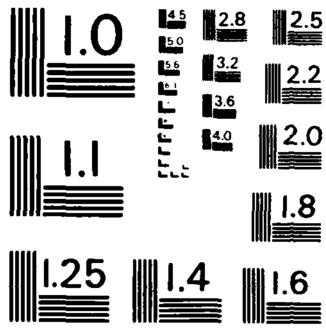


FIGURE B-6 PLAN LOCATION OF STRUCTURAL MEASURES FOR ROCK HALL, MARYLAND

AD-A161 477 CHESAPEAKE BAY TIDAL FLOODING STUDY APPENDIX A PROBLEM IDENTIFICATION APP..(U) CORPS OF ENGINEERS BALTIMORE MD BALTIMORE DISTRICT SEP 84 CHB-84-T-APP-A-B-C 3/4

UNCLASSIFIED F/G 13/2 NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Plan RH-8

In this plan three residential units would receive utility additions, one unit would be raised 2'-8", 18 structures would be acquired and demolished, and 13 trailers would be relocated. Commercial protection would consist of 2 acquisitions and demolitions, 1 relocation, 5 floodproofings, and 14 floodwalls. All the other structures have first floors at or above the 25-year flood level (6 feet NGVD).

Plan RH-9

This plan would consist of providing utility additions to three residential structures, raising one unit 1'-4", three units 2'-8", and one unit 4'-0", relocating one unit and 16 trailers, and acquiring and demolishing 56 others. Preventing damages in the commercial sector would consist of acquiring and demolishing two structures, relocating one unit, floodproofing ten units, and placing floodwalls around 13 units. This plan is designed to protect against the 50-year flood occurrence of 7 feet NGVD. All other structures in the study area have first floors at or above this flood height.

Plan RH-10

This plan would provide for 7 utility additions, raising of 13 units 2'-8" and 1 unit 4'-0", relocating 2 houses and 26 trailers, and 91 acquisitions and demolitions. Twenty-six commercial units would be effected: 2 demolitions, 1 relocation, 10 floodproofings, and 13 floodwalls. This plan would provide protection against the 80-year flood of 8 feet NGVD. The remaining structures in the study area have first floors at or above this level.

IMPACT ASSESSMENT AND EVALUATION

Plans RH-1 through RH-6

The floodwall/levee plans investigated would, depending on the plan, completely encircle portions of the Town of Rock Hall and protect against storms with approximate return intervals from 140 years to the standard project flood. In general, levee sections were selected where there was sufficient area between the shoreline and development for their construction and floodwalls were chosen for restricted space areas or where significant wave attack was expected. Design parameters, approximate costs, typical sections, and all assumptions made concerning both floodwalls and levees are provided in Appendix E - Engineering Design and Cost Estimates.

If the structural plans for Rock Hall were implemented, use of the shoreline would be severely restricted and modifications would have to be made to provide access to the existing wharves and piers. During design, consideration would have to be given to providing a means of removing water draining into the landside area of the protection. Generally, either a ponding area and/or a pumping station would be provided to avoid flooding from the interior drainage, and many closure structures would be required for local roadway crossings. Construction impacts associated with the building of plans with floodwalls and levees in Rock Hall would include noise pollution, destruction of benthic organisms, turbidity and siltation, destruction of significant amounts of adjacent wetlands, the creation of dust, and severe adverse effects on the aesthetic conditions of the area.

Plans RH-1, RH-3, and RH-5 would provide design protection against a tidal flood of nine feet above NGVD (approximately a 140-year occurrence). Flood control benefits depend on the level, not the method, of protection. Accordingly, average annual benefits (AAB) for Plan RH-1 would be approximately $137,000, for Plan RH-3, $107,000, and for Plan RH-5, $50,400 (reference Appendix F - Economics). Plans RH-2, RH-4, and RH-6 would provide design protection against a tidal flood of 12 feet NGVD (standard project flood). Plan RH-2 would provide AAB of approximately $194,000, Plan RH-4, $139,000, and Plan RH-6, $72,000. Benefits are based on reductions in flood damages to existing structures as well as labor employed during construction and the affluence factor.

Plans RH-7 through RH-10

The nonstructural plans investigated for Rock Hall consist of combinations of the various nonstructural management measures described earlier. Plan RH-7 would reduce the flood hazard experienced by the community and protect to the level of the 15-year flood (5 feet above NGVD). Plans RH-8, RH-9 and RH-10 would protect to the levels of the 25-year (6 feet NGVD), 50-year (7 feet NGVD) and 100-year (8 feet NGVD) floods, respectively. All costs, design parameters, typical installations, and assumptions regarding the applicability of each of the alternatives are provided in Appendix E - Engineering Design and Cost Estimates.

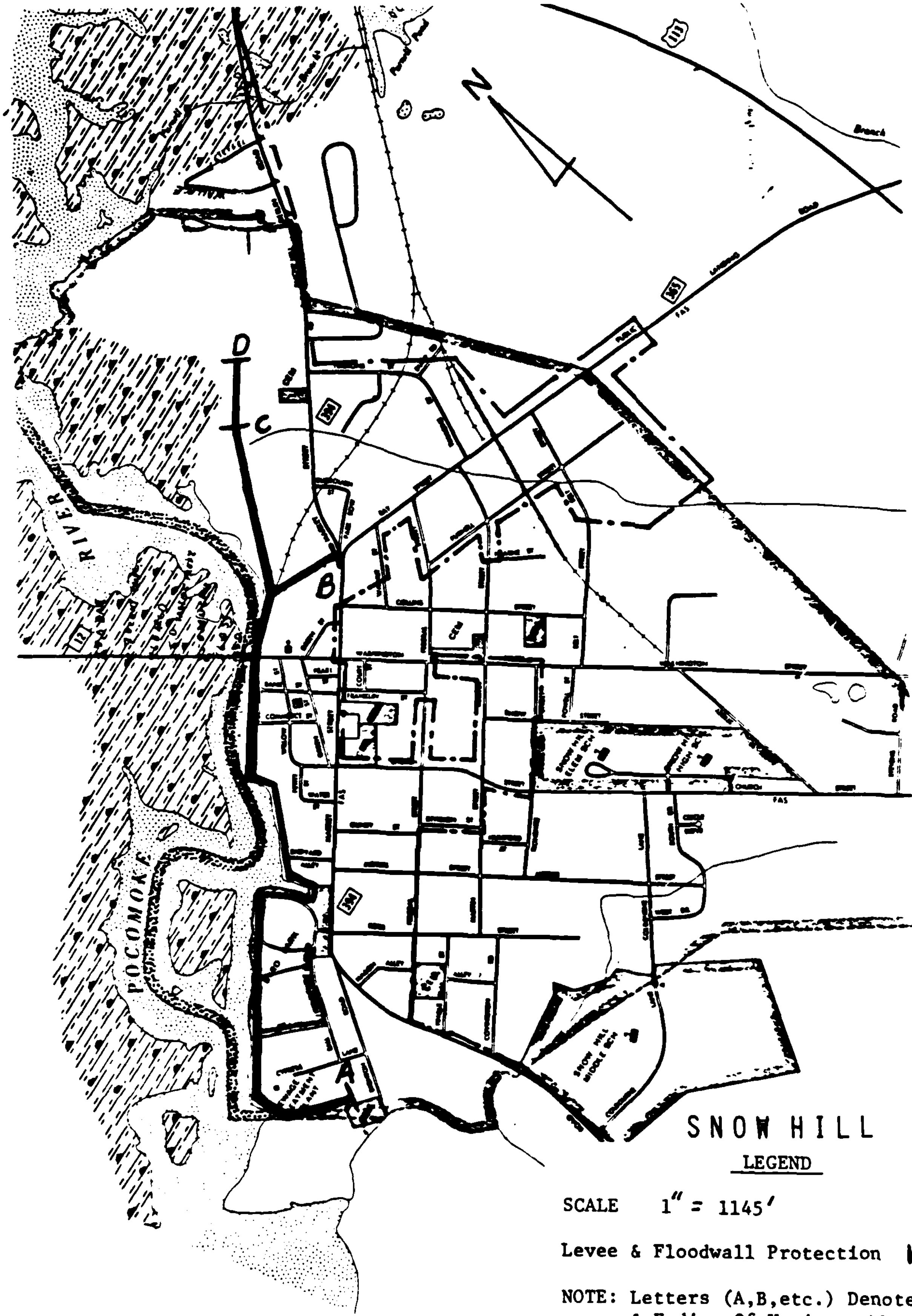
The nonstructural plans for Rock Hall would not have a significant impact on the environment. Minor disturbances such as noise, the potential creation of dust and disruption of the aesthetic conditions would be short-term and localized. The relocation and acquisition and demolition of some structures may create new open areas for wildlife or recreation, but would have some social impact on those whose life styles would be interrupted by relocation. Construction of small floodwalls may result in the adverse impacts associated with structural alternatives, although to a much smaller degree. The AAB for Plan RH-7 (5 feet NGVD protection), is $22,000 while the AAB for Plans RH-8, RH-9 and RH-10 (6, 7, and 8 feet NGVD protection), respectively, are $51,000, $92,000 and $125,000. Benefits are based on the reduction in flood damages as well as labor employed during construction and the affluence factor (reference Appendix F - Economics).

SNOW HILL, MARYLAND

DESCRIPTION OF PLANS

Plan SH-1

This plan would consist of an earthen levee 1,510 feet long and a reinforced concrete floodwall 5,680 feet long with a top elevation of 9 feet NGVD. The combination of levee and wall would protect the entire study portion of the community against the 70-year flood occurrence (6 feet NGVD). The alignment is shown in Figure B-7, reference points A-C. The general location of the following plans are also indicated in Figure B-7, with appropriate references.



LEGEND

SCALE 1" = 1145'

Levee & Floodwall Protection

NOTE: Letters (A,B,etc.) Denote Beginning & Ending Of Various Alternatives

FIGURE B-7 PLAN LOCATION OF STRUCTURAL MEASURES FOR SNOW HILL, MARYLAND

Plan SH-2

This plan would consist of a concrete floodwall 5,680 feet long and an earthen levee 400 feet long (top height of 9 feet NGVD) protecting the area between the sewage treatment plant and Bay Street as shown by reference points A-B. The protection provided by this plan would be for the 120-year return interval (6 feet NGVD).

Plan SH-3

This plan would be the same as plan SH-1 in location, but would protect the study area against the standard project flood (8 feet NGVD reference points A-D). The levee would be 2,080 feet long and the floodwall would be 5,840 feet long with a top elevation of 11 feet NGVD. Adding the extra length (C-D) is necessary in order to tie out the structure at the 11-foot contour.

Plan SH-4

Similar to plan SH-2, protection would be provided against the standard project flood (8 feet NGVD). With a top elevation of 11 feet NGVD, the levee would be 620 feet in length and the floodwall 5,840 feet (reference points A-B).

Plan SH-5

In this plan only seven commercial units would be affected; one would be raised 1'-4", two would be floodproofed, and four units would have floodwalls. The remaining structures have first floors at or above this design protection from the 25-year flood (5 feet NGVD).

Plan SH-6

One residential structure would be acquired and demolished with this plan. The commercial protection would consist of one structure acquired and demolished, two structures raised 2'-8", five floodproofed, and three receiving floodwalls. This plan is designed for the 70-year flood occurrence of 6 feet NGVD. All other structures have first floors at or above this level.

Plan SH-7

This plan would consist of acquiring and demolishing three residential structures. The protection of the commercial structures would consist of acquiring and demolishing five structures, raising one unit 2'-8", floodproofing five units, and placing floodwalls around three structures. This plan is designed for the 220-year flood (7 feet NGVD).

IMPACT ASSESSMENT AND EVALUATION

Plans SH-1 through SH-4

The floodwall/levee plans investigated would, depending on the plan, provide flood protection for the low-lying areas of the Town of Snow Hill and protect against storms with approximate return intervals from 70 years up to the standard project flood. In general, levee sections were selected where there was sufficient area between the shoreline and development for their construction and floodwalls were chosen for

restricted space areas or where significant wave attack was expected. Design parameters, approximate costs, typical sections, and all assumptions made concerning both floodwalls and levees are provided in Appendix E - Engineering Design and Cost Estimates.

The construction impacts associated with the building of the floodwall/levee plans in Snow Hill would be essentially the same as Plans CA-1 through CA-6 in Cambridge. However, a more significant social impact would be felt relative to the aesthetic conditions, especially in the Byrd Park area.

Plans SH-1 and SH-2 would provide design protection against a tidal flood of 6 feet above NGVD (approximately a 70-year occurrence). Flood control benefits depend on the level, not the method, of protection. Accordingly, average annual benefits (AAB) for Plan SH-1 would be approximately $5,500 and for Plan SH-2, $5,000 (reference Appendix F - Economics). Plans SH-3 and SH-4 would provide design protection against a tidal flood of 8 feet above NGVD (standard project flood). Plan SH-3 would provide AAB of approximately $9,000 and Plan SH-4, $8,800. Benefits are based entirely on reductions in flood damages to existing structures.

Plans SH-5 through SH-7

The nonstructural plans investigated for Snow Hill consist of combinations of the various nonstructural management measures described earlier. Plan SH-5 would reduce the flood hazard experienced by the community and protect to the level of the 25-year flood (5 feet above NGVD). Plans SH-6 and SH-7 would protect to the levels of the 70-year (6 feet NGVD) and 220-year (7 feet NGVD) floods, respectively. All costs, design parameters, typical installations, and assumptions regarding the applicability of each of the alternatives are provided in Appendix E - Engineering Design and Cost Estimates.

The nonstructural plans for Snow Hill would not have a significant impact on the environment. Minor disturbances such as noise, the potential creation of dust and disruption of the aesthetic conditions would be short-term and localized. The relocation and acquisition and demolition of some structures may create new open areas for wildlife or recreation, but would have some social impact on those whose life styles would be interrupted by relocation.

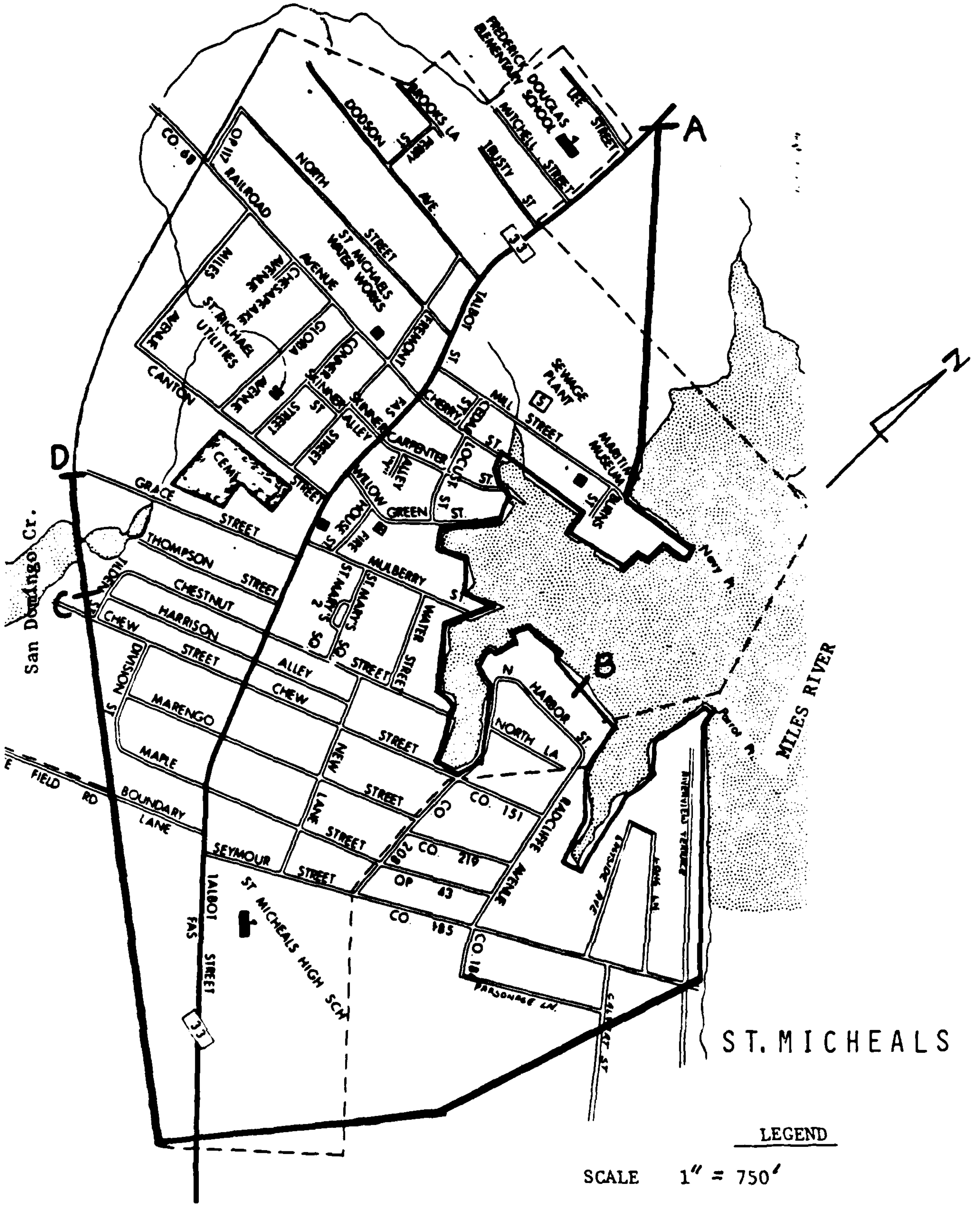
The AAB for Plan SH-5 (5 feet NGVD protection), is $3,000 while the AAB for Plans SH-6 and SH-7 (6 and 7 feet NGVD protection), respectively, are $6,000 and $8,000. Benefits are based entirely on the reduction in flood damages to those structures receiving nonstructural protection (reference Appendix F - Economics).

ST. MICHAELS, MARYLAND

DESCRIPTION OF PLANS

Plan SM-1

This plan would provide St. Michaels with protection against the 100-year flood (7-foot design level). It would consist of 2,590 linear feet of levee and 11,395 feet of floodwall with a top elevation of 10 feet NGVD. This plan is pictured in Figure B-8, reference points A-B and D-C (two sections). The general location of the following plans are also shown in Figure B-8 with appropriate references.



LEGEND

SCALE 1" = 750'

Levee & Floodwall Protection

NOTE: Letters (A,B,etc.) Denote Beginning & Ending Of Various Alternatives

FIGURE B-8 PLAN LOCATION OF STRUCTURAL MEASURES FOR ST. MICHAELS, MARYLAND

Plan SM-2

This plan consists of 8,690 feet of earthen levee combined with 15,200 feet of reinforced concrete floodwall to protect the community against the 9-foot flood height (450-year occurrence). The top of protection would be at 12 feet NGVD. The alignment is shown by reference points A through D.

Plan SM-3

In this nonstructural plan four residential units would receive utility additions while the commercial protection would consist of one structure being floodproofed, one structure being acquired and demolished, and ringing five others with floodwalls. This plan was designed to minimize the damage that could be caused by the 45-year (6 feet NGVD) flood. The remaining structures in the community have first floor levels at or above 6 feet NGVD.

Plan SM-4

This plan would provide utility additions to five residential units and raise two units 1'-4". One commercial structure would be acquired and demolished, one would be floodproofed, and five would receive floodwalls. The remaining structures in the community have first floors at or above this plan's flood design level of 7 feet NGVD (100-year occurrence).

IMPACT ASSESSMENT AND EVALUATION

Plans SM-1 and SM-2

The floodwall/levee plans investigated would, depending on the plan, encircle the low-lying areas of the Town of St. Michaels and protect against storms with approximate return intervals from 100 to 450 years. In general, levee sections were selected where there was sufficient area between the shoreline and development for their construction and floodwalls were chosen for restricted space areas or where significant wave attack was expected. Design parameters, approximate costs, typical sections, and all assumptions made concerning both floodwalls and levees are provided in Appendix E - Engineering Design and Cost Estimates.

The construction impacts associated with the building of floodwall/levee plans in St. Michaels would be essentially the same as Plans CA-1 through CA-6 in Cambridge. However a more significant social impact would be felt relative to the aesthetic conditions, especially in the harbor and Chesapeake Maritime Museum areas.

Plan SM-1 would provide design protection against a tidal flood of seven feet above NGVD (approximately a 100-year occurrence). Flood control benefits depend on the level, not the method of protection. Accordingly, average annual benefits (AAB) for Plan SM-1 would be approximately $10,000 (reference Appendix F - Economics). Plan SM-2 would provide design protection against a tidal flood of 9 feet above NGVD (approximately a 450-year occurrence). Plan SM-2 would provide AAB of approximately $16,000. Benefits are based entirely on reductions in flood damages to existing structures.

Plans SM-3 and SM-4

The nonstructural plans investigated for St. Michaels consist of combinations of the various nonstructural management measures described earlier. Plan SM-3 would reduce the flood hazard experienced by the community and protect to the level of the 45-year flood (6 feet above NGVD). Plan SM-4 would protect to the level of the 100-year flood (7 feet NGVD). All costs, design parameters, typical installations, and assumptions regarding the applicability of each of the alternatives are provided in Appendix E - Engineering Design and Cost Estimates.

The nonstructural plans for St. Michaels would not have a significant impact on the environment. Minor disturbances such as noise, the potential creation of dust and disruption of the aesthetic conditions would be short-term and localized. The relocation and acquisition and demolition of some structures may create new open areas for wildlife or recreation, but would have some social impact on those whose life styles were interrupted by relocation. Construction of small floodwalls may result in the adverse impacts associated with structural alternatives, although to a much smaller degree.

The AAB for Plan SM-3 (6 feet NGVD protection), is $8,000 while the AAB for Plan SM-4 (7 feet NGVD protection), is $11,000. Benefits are based entirely on the reduction in flood damages to those structures receiving nonstructural protection (reference Appendix F - Economics).

TILGHMAN ISLAND, MARYLAND

DESCRIPTION OF PLANS

Knapps Narrows divides the study area of Tilghman Island into two sections. The smaller northern section consists of a residential area and commercial seafood establishments along the Narrows. The larger southern section consists of the two communities of Tilghman and Avalon. Plans consisting of concrete floodwalls and earthen levees around the northern and southern sections were investigated independently of each other. The general location of the plans is shown in Figure B-9.

Plan TI-1

This plan would protect the larger area south of Knapps Narrows against the 90-year flood return interval (6 feet NGVD). A 7,510-foot levee would be combined with a 10,050-foot concrete floodwall at a top height of 9 feet NGVD and would ring the entire area.

Plan TI-2

This plan is designed to protect the smaller northern section of the study area against the 90-year flood (6 feet NGVD). The floodwall would be 4,100 feet long and the levee would be 1,250 feet long, both with a top elevation of 9 feet NGVD.

Plan TI-3

This plan would protect the same area as TI-1. It has the identical protection alignment, but is designed for the standard project flood (8 feet NGVD) with a top height of 11 feet NGVD.

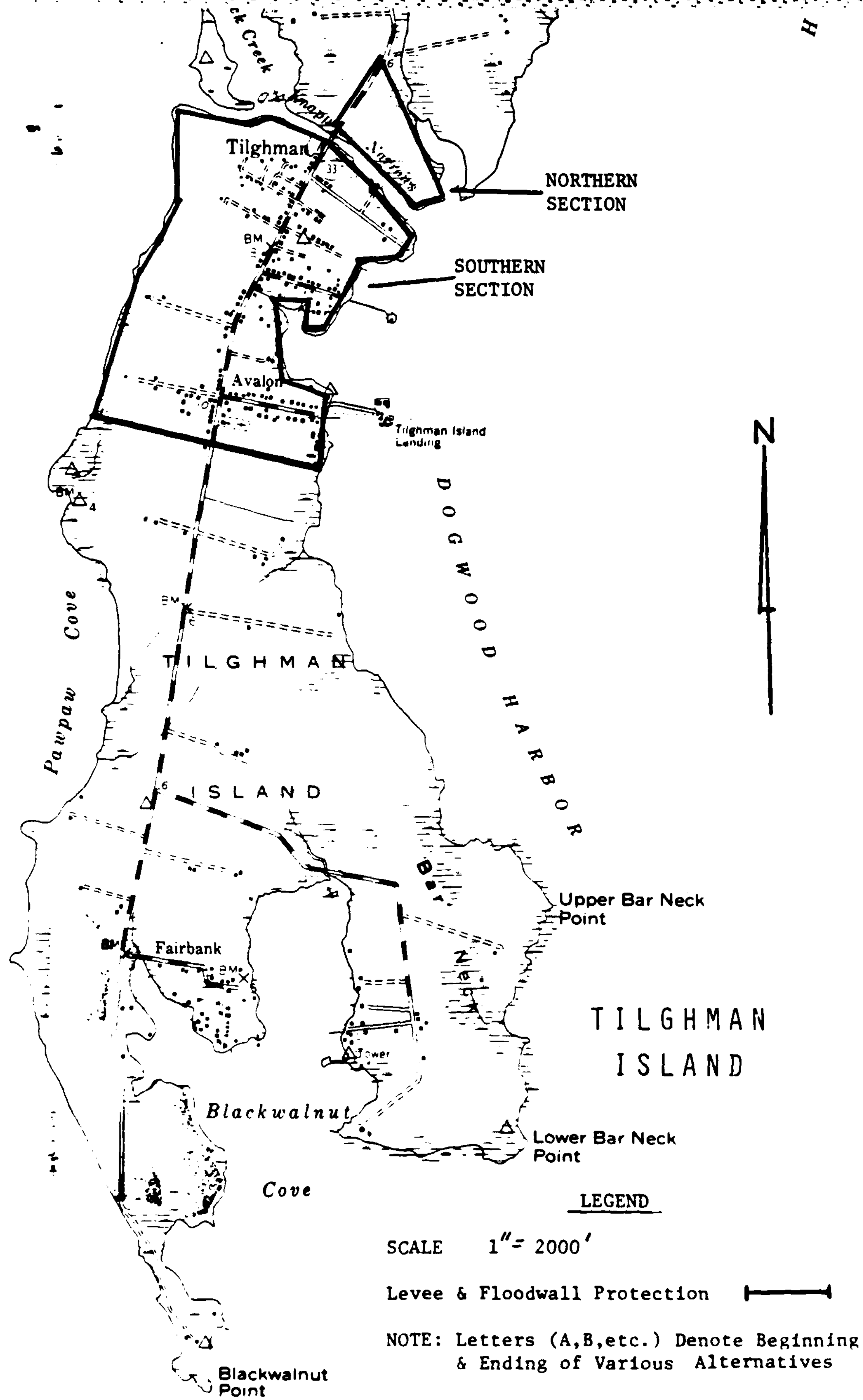


FIGURE B-9 PLAN LOCATION OF STRUCTURAL MEASURES FOR TILGHMAN ISLAND, MARYLAND

Plan TI-4

Identical to TI-2, this plan would protect the same area and have the same structural alignment. The degree of protection is 8 feet NGVD, increased from the 90-year level to the level of the standard project flood (11 feet top of protection).

Plan TI-5

In this nonstructural plan one residential unit would be acquired and demolished, three trailers relocated, and two commercial structures ringed with floodwalls. This plan is designed for protection against the 15-year flood height of 4 feet NGVD. All other first floors are above this height.

Plan TI-6

This plan would consist of raising five residential units 1'-4", relocating one home and five trailers, and acquiring and demolishing 12 units. Commercial protection would raise two structures 1'-4", floodproof one structure, and provide floodwalls around four others. Tilghman's remaining structures have first floors at or above the design height of 5 feet NGVD (40-year flood protection plan).

Plan TI-7

With this plan seven homes would be raised 1'-4" and five would be raised 2'-8"; one home and eight trailers would be relocated; and 27 homes would be acquired and demolished. For the commercial structures, two would be acquired and demolished, two raised 2'-8", one floodproofed, and six would receive floodwalls. The remaining structures in the Tilghman study area have first floors at or above this plan's flood stage of 6 feet NGVD (90-year flood return interval).

IMPACT ASSESSMENT AND EVALUATION

Plans TI-1 through TI-4

The floodwall/levee plans investigated would, depending on the plan, completely encircle portions of Tilghman Island and protect against storms with approximate return intervals from 90 years up to the standard project flood. In general, levee sections were selected where there was sufficient area between the shoreline and development for their construction and floodwalls were chosen for restricted space areas or where significant wave attack was expected. Design parameters, approximate costs, typical sections, and all assumptions made concerning both floodwalls and levees are provided in Appendix E - Engineering Design and Cost Estimates.

The construction impacts associated with the building of floodwall/levee plans on Tilghman Island would be essentially the same as Plans CA-1 through CA-6 in Cambridge. However, a more substantial amount of wetlands and fringe marshes would be destroyed during construction.

Plans TI-1 and TI-2 would both provide design protection against a tidal flood of six feet above NGVD (approximately a 90-year occurrence). Flood control benefits depend on the level, not the method, of protection. Accordingly, average annual benefits (AAB) for

Plan TI-1 would be approximately $3,300, and for Plan TI-2, $400 (reference Appendix F - Economics). Plans TI-3 and TI-4 would provide design protection against a tidal flood of 8 feet above NGVD (the standard project flood). Plan TI-3 would provide AAB of approximately $6,400 and Plan TI-4, $1,100. Benefits are based entirely on reductions in flood damages to existing structures.

Plans TI-5 through TI-7

The nonstructural plans investigated for Tilghman Island consist of combinations of the various nonstructural management measures described earlier. Plan TI-5 would reduce the flood hazard now being experienced by the community and protect to the level of the 15-year flood (4 feet above NGVD). Plans TI-6 and TI-7 would protect to the levels of the 40-year (5 feet NGVD) and 90-year (6 feet NGVD) floods, respectively. All costs, design parameters, typical installations, and assumptions regarding the applicability of each of the alternatives are provided in Appendix E - Engineering Design and Cost Estimates.

The nonstructural plans for Tilghman Island would not have a significant impact on the environment. Minor disturbances such as noise, the potential creation of dust and disruption of the aesthetic conditions would be short-term and localized. The relocation and acquisition and demolition of some structures may create new open areas for wildlife or recreation, but would have some social impact on those whose life styles would be interrupted by relocation.

The AAB for Plan TI-5 (4 feet NGVD protection), is $2,500 while the AAB for Plans TI-6 and TI-7 (5 and 6 feet NGVD protection, respectively) are $12,500 and $21,000. Benefits are based entirely on the reduction in flood damages to those structures receiving nonstructural protection (reference Appendix F - Economics).

CAPE CHARLES, VIRGINIA

DESCRIPTION OF PLANS

Cape Charles has an operational procedure for disasters. It includes a separate emergency response plan which becomes effective when a northeaster and/or hurricane approaches the area. The evacuation route and shelter are identified, and the route has been located on a storm evacuation map prepared by the National Ocean Survey for the National Weather Service. Most of the roads on that route, comprising a ride of approximately seven minutes by automobile to the high school in Eastville, are at a high level, with the exception of a small section within the town limits of Cape Charles itself.

Structural Measures

Development of a tidal flood protection project by the Corps of Engineers would require raising the bulkhead to the level of the 100-year storm with wave action (or possibly higher) plus freeboard, the construction of dikes on the north and south sides of the town to the same level, the reconstruction of some of the storm outlets and the installation therein of tide gates, and the construction of a pumping station as shown in Figure B-10. Such a project would clearly not be warranted on the basis of the benefits to be derived.

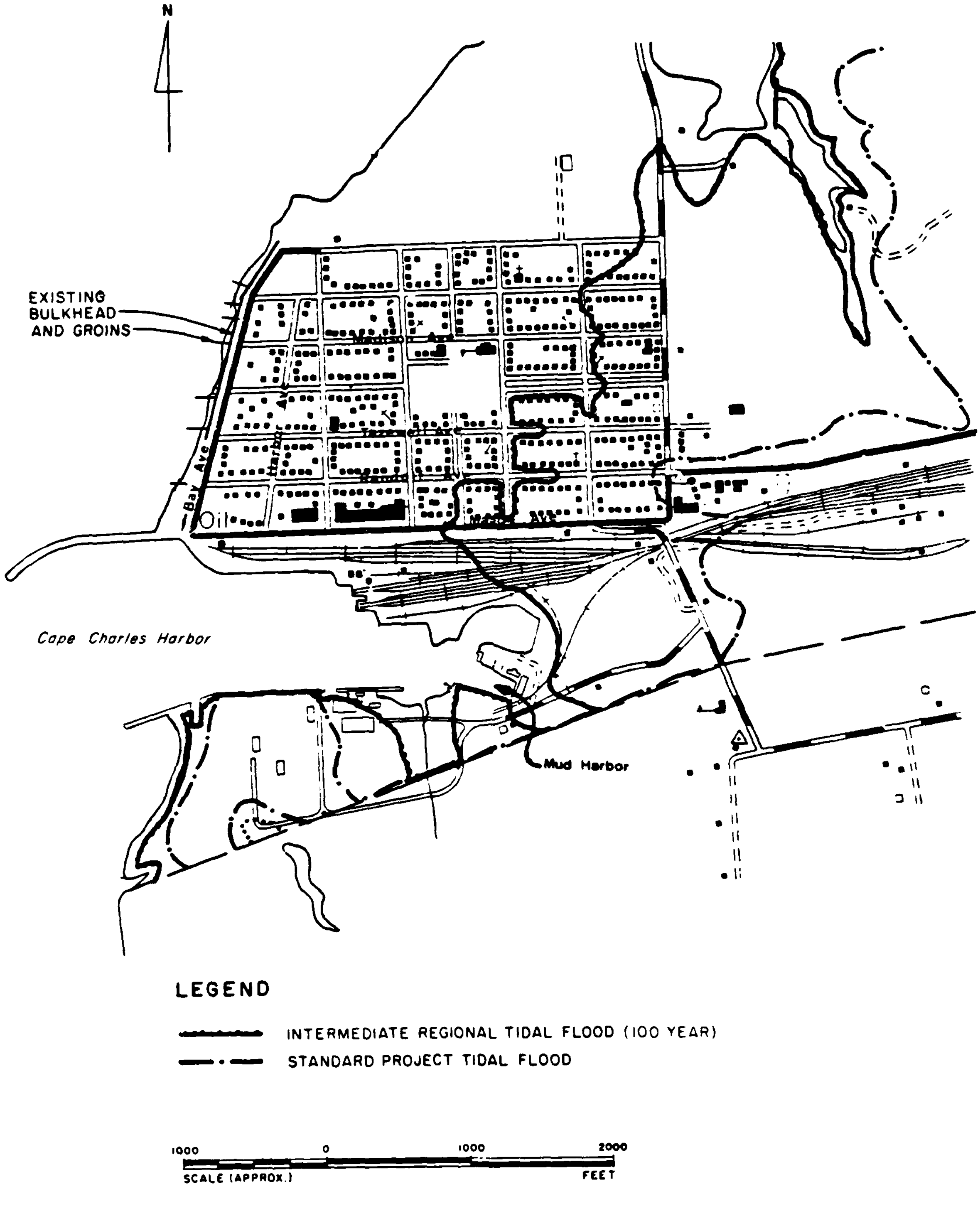


FIGURE B-10 CAPE CHARLES FLOOD AREA

Instead, it would appear desirable for the town to at least consider raising the ground on the north and south sides of the town to elevation 8.0 feet, the level of the top of the bulkhead. The Soil Conservation Service has completed its improvements to the bulkhead, primarily the construction of the nine groins. The storm outlets, which drain the entire town, range in size from 18 to 24 inches. They are not functional due to a buildup of sand and debris within them. Maintenance at the outer ends of the drains in Chesapeake Bay is extremely difficult. During a heavy rainfall, the center of the town is flooded due to the blockage in the drains. The town manager plans to correct the situation with financial assistance from the State Highway Department. The installation of flap gates may be considered at the outer ends of the storm drains. The above action would protect the town from storms in Chesapeake Bay to at least the level of the top of the bulkhead.

Nonstructural Measures

Two basic nonstructural plans are indicated in Table B-5. Consideration was given to certain nonstructural measures for the protection of structures below elevation 8 feet. Two commercial establishments and 11 residences have their first floor level at elevation 7, or 1-foot below the level of the 100-year flood. These structures contain no basements. The residences are single-family homes of wood or brick on block foundations. The commercial establishments have a slab foundation. In addition there are 15 residences whose first floor is 2 feet above the 100-year flood but which contain basements.

TABLE B-5

NONSTRUCTURAL MEASURES
CONSIDERED FOR CAPE CHARLES, VIRGINIA

Protection to Elevation (NGVD)	Flood Stage Frequency (Years)	Nonstructural Measures Considered
8	100	1. Raise 11 residences and 2 commercial establishments. 2. Remove household mechanical and electrical equipment from the basement of 15 additional residences. Relocate to a first-floor utility room addition. 3. Construct temporary closures for basement windows of the 15 residences.
7	35	1. The first floor of all structures are at elevation seven or higher. However, there are eight residences whose first floors are at elevation nine but whose basement windows are at elevation six. Remove household mechanical and electrical equipment from basements. Relocate to a first-floor utility addition. 2. Construct temporary closures for basement windows.

Floodproofing above the first floor by flood shields or waterproofing compounds was not considered practical for residential structures. The demolition or relocation of the residences and commercial establishments also was not feasible. Since the first floor of the buildings is only 1-foot below the level of the 100-year flood, raising the structures was deemed to be an acceptable floodproofing measure. In the case of the 15 residences above the 100-year tidal flood level that have basements, consideration was given to removing the utilities and having temporary closures installed in the basement windows.

IMPACT ASSESSMENT AND EVALUATION

The plans studied would have little impact on the community except during construction operations. The addition of earth levees on the north and south sides of the town to the same level as the top of the existing bulkhead could be so sloped as to create no adverse effect. A closure may be required on the south side where the commercial area is located.

Raising the few residential buildings and stores, constructing small adjoining buildings to house existing utilities that are now located in the basements of these structures, and providing temporary closures for windows in basements would have practically no effect on adjacent property or on the community.

No environmental and/or biological factors appear to be involved with the above plans. There are no existing sand dunes along the shoreline. Therefore, mitigation, due to a deterioration of fish and wildlife and/or factors involving the environment, is not necessary.

HAMPTON ROADS, VIRGINIA

DESCRIPTION OF PLANS

The Norfolk District Corps of Engineers recently completed a hurricane protection and beach erosion control study of the entire Willoughby area and has forwarded it to higher authority for review. The report recommended that a protective beach be constructed along the entire 7.3-mile Chesapeake Bay shoreline of the City of Norfolk where an adequate berm does not already exist.

The cities of the Hampton Roads area all have plans which go into effect in the event of a hurricane or northeaster. This is required by the state for any city on the Bay. Evacuation routes and, in some cases, shelters are identified on a storm evacuation map prepared by the National Ocean Survey for the National Weather Service. Unfortunately, portions of the evacuation routes are below the level of the 100-year flood. The possibility of persons becoming marooned on a high area surrounded by water is an important factor, and all means of preventing such an occurrence should be exercised. Citizens should be made aware of the potential danger areas, and there should be plans to carry out orderly and timely evacuation in the event of a storm.

An example of preparedness is described for the City of Portsmouth. The Office of Civil Defense coordinates activities in the event of the need for flood fighting and emergency evacuation. The city has a contract with the Northeastern Weather Service in Massachusetts to provide information by telephone on anticipated high winds and tides, as well as other information concerning weather conditions. In the past, this

service has proven to be very accurate. City personnel also maintain contact with the U.S. Weather Service. During a major tidal event, tide charts are maintained as are weather reports. Streets in low-lying areas are barricaded, and the new West Norfolk Bridge would be closed to traffic to protect motorists from being trapped since both ends of the bridge could be submerged. The Public Works Department has crews available to place sandbags in areas where needed. Civil Defense has the manpower and radio communication available together with salvage crews, rescue crews, and rescue craft to reach people who might become stranded in low-lying areas of the city. Civil Defense can also obtain police, fire, or other assistance as required.

No investigations were made of the entire Hampton Roads city complex to determine the feasibility and/or justification for tidal flood protection measures. In the early 1960's, studies of such structures as floodwalls were investigated at three localities in Norfolk, two in Portsmouth, and two in Hampton. Except for the downtown business area in Norfolk, none showed economic feasibility. Since then, floodwalls have been constructed for the protection of the downtown Norfolk and Portsmouth areas. Considerable development has also taken place since then.

For purposes of this preliminary report, a field reconnaissance was made of several small typical areas in Norfolk to determine the practicality of flood protection by floodwalls. Also a field reconnaissance was made to determine the amount of development in the previously studied areas and in the areas inundated by the 100-year flood in Chesapeake and Hampton. A reconnaissance study is underway for the Salter's Creek area in Newport News. Also nonstructural measures primarily consisting of the raising of houses were considered in one area in Hampton.

Structural Measures

In 1980, a preliminary reconnaissance of several small typical areas in Norfolk was made to identify areas wherein structural measures could be employed. Four sites on the Lafayette River and Wayne Creek in Norfolk, as shown in Figure B-11, were chosen because of their flood reduction potential and accessibility. Sites N-1 and N-2 along Tidewater Drive are concrete bridges, each spanning 50-foot tidal estuaries of the Lafayette River and its tributary, Wayne Creek.

A field investigation indicated that installing dams at these two points does not seem practical. A large volume of water flows past these sites during the tidal exchange, nourishing large areas of marshland. In addition, there does not appear to be sufficient development within the area to justify construction of a dam, together with a spillway and gates, for flood protection.

Upstream from Site N-2 is a timber trestle railroad bridge (N-3) which would not provide sufficient support for a protective structure. The bridge is flanked by wide mud flats which would require a long structure across the stream and create ecological problems due to the adjacent marshland.

Site N-4 is a three-section, concrete bridge along Chesapeake Boulevard upstream from the railroad bridge. At this point, the creek is 30 feet wide and drains a substantial area of marshland which forms the upper reach of Wayne Creek. There are few houses at a low level along this reach.


NORFOLK
Sewells Gardens
Green Hill Farms
Lakewood
Lafayette Shores
Willard Park
Riverview
Fairmount Park
Norview
Greenwood
Estabrook
N-3
N-4
PICADILLY
WELLINGTON

The above investigations indicate little, if any, justification for tidal protective measures. Whether this situation is typical for the entire Hampton Roads city complex is conjectural. For example, three areas were investigated in connection with the 1962 study in the Norfolk area. At that time, the Hague and the Tidewater Drive area, both fronting the Elizabeth River on its Eastern Branch, did not indicate economic feasibility. However, there has been considerable development in these areas since that time. Also, the City of Portsmouth has found it justifiable to construct a major floodwall to protect its downtown area. The development in these areas and in the Hampton Roads city complex in the last 20 years has been substantial.

It would, therefore, appear appropriate to make a comprehensive investigation of the entire Hampton Roads city complex to determine the need for and justification of structural measures for the protection of portions of this urban complex.

This report includes an estimate of cost for the construction of a floodwall to protect a portion of the Fox Hill area in Hampton. The Fox Hill area, shown in Figure B-12, was severely flooded by the March 1962 high water. This area is a large, broad, flat, low-lying plain surrounded on three sides by water. The structural protection proposed consists of a floodwall 6,200 feet long which will protect approximately 50 structures to the 100-year recurrence level.

Nonstructural Measures

As with the structural measures, no investigations were made of the entire Hampton Roads area. However, the Fox Hill area was again chosen as a sample study. In 1980, a field survey and property assessment of 379 buildings in Fox Hill was conducted. A section typical of the area was then selected for detailed analysis. It contained 61 houses, most of which are located on the main street, Beach Road. This section contains one of the lowest areas in Fox Hill, and the first floor of over 50 percent of the houses is estimated to be below the 25-year tidal flood level.

The nonstructural plans identified for this area consist solely of the raising of structures. The purchase and demolition of property and/or the relocation of houses do not seem to be practical alternatives. Little vacant land is available in the immediate vicinity outside the flood plain, and the cost of its purchase would undoubtedly be prohibitive. Also many of the people appear to be long-time residents whose families have lived in Fox Hill for generations. Therefore, the two nonstructural plans considered consist of raising 34 structures to the 25-year flood level and raising 59 structures to the 100-year flood level.

IMPACT ASSESSMENT AND EVALUATION

Structural measures that were investigated, such as dams across the small estuaries, would have to be carefully designed to insure the free flow of tidal waters under normal conditions so as not to affect the marshland areas along these streams. There are additional downtown areas in Norfolk and the coastal area of Hampton wherein tidal flood protection walls could be investigated without affecting marshland areas.

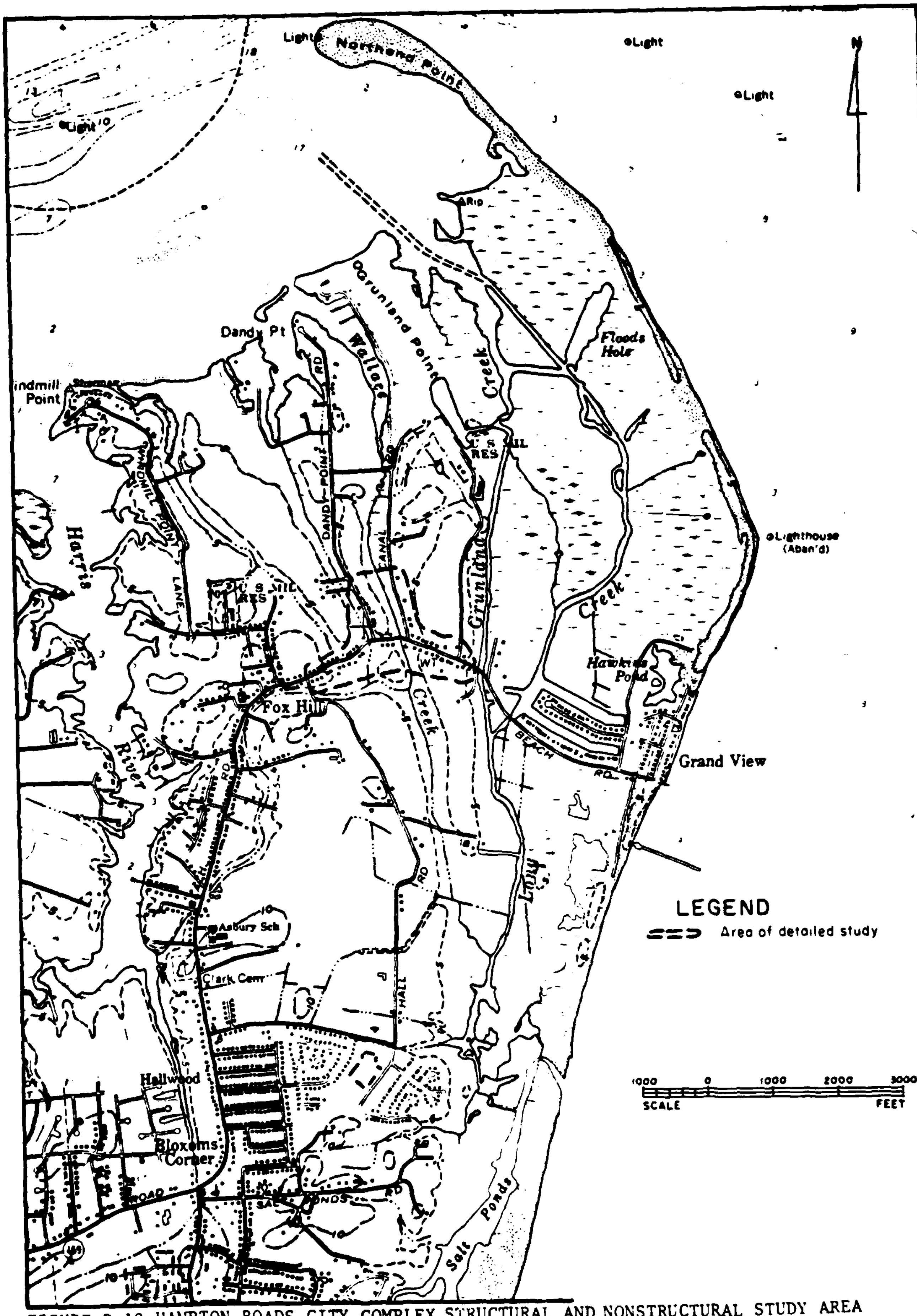


FIGURE B-12 HAMPTON ROADS CITY COMPLEX STRUCTURAL AND NONSTRUCTURAL STUDY AREA IN HAMPTON

The raising of houses, whether it be in Hampton, where an area was investigated, or any of the other areas throughout the Hampton Roads city complex, would create social problems. Some people would undoubtedly be required to leave their homes for a period of time during the raising operations.

POQUOSON, VIRGINIA

DESCRIPTION OF PLANS

Poquoson has an operational procedure for disasters. It includes a separate emergency response plan which becomes effective when a northeaster and/or hurricane approaches the area. The evacuation routes and shelter are identified and the routes have been located on a storm evacuation map prepared by the National Ocean Survey for the National Weather Service. Unfortunately portions of the routes are below the level of the 100-year flood.

Structural Measures

There are no protective barriers such as sand dunes or seawalls between the developed portions of the city and the surrounding waters. The city is concerned about drainage following an unusually high tide or heavy rainfall. The existing drainage systems are small and inadequate. Thus, when tidal waters reach the area, it takes a long time for floodwaters to run off. There is a drainage plan for most of the city. Local officials believe that if drainage were faster, this would mitigate flood levels around existing homes. There are separate storm and sewerage pipelines. The city has constructed a small dike in an area near Plum Tree Island and is presently using the area as a garbage fill. The area will also give a limited amount of protection from wave action to the immediate area.

It would not be practical to protect the city with a levee or wall. Such a plan would require that 14 miles of dike encircle the entire city. On the north side, the dike would have to circumvent six large peninsulas in which streets and houses have been constructed near the edge of the water. In a number of areas, and particularly throughout the east side, the dike would have to be high enough to protect against the sweep of Chesapeake Bay and wave action. Three or four pumping stations would be required to ensure proper drainage for the 3,400 acres that would be encircled by the dike. Such a plan would have to include adjustments to the present interior drainage facilities. Closures would be required across the numerous streets or they would have to be raised for ingress and egress from the peninsulas. Undoubtedly, there would be objection to obstruction of the view of Chesapeake Bay and to the difficulty of moving boats over or through the dike and into the coastal waters. Furthermore, there is no concentration of structures, such as apartment houses or commercial developments in the low-lying areas, to warrant the construction of walls for their protection. To subdivide the community with a series of floodwalls with closures and pumping stations is also not deemed practical or justifiable. For the above reasons, no further consideration was given to such a plan of protection.

Construction of a dike along Plum Tree Island that would reduce wave action only is also not practical. Sections of the city not protected by the dike would still be affected by wave action. In addition, the entire city would still be flooded by the tidal waters. Furthermore, Plum Tree Island is now a national wildlife refuge and construction there would be a serious problem from an environmental standpoint.

Development of an improved drainage system might provide better drainage so that the floodwaters could run off more rapidly and thereby reduce the time for tidal flooding. However, tidal damage would still occur even though the time period is lessened. Development of canals and/or pumping systems to improve drainage is not within the authority of the Corps. It was concluded that structural works for the protection of Poquoson are not deemed practical or economically justifiable.

An inspection of Poquoson Middle School indicated that it has an auditorium that seats about 400. The stage and halls could accommodate an additional number of persons. It is more or less centrally located and residents who so desire now seek shelter at the school during high water. The first floor of the building is fairly high. It could either be flood proofed or a wall could protect the structure, if necessary, to a level approaching the elevation of a rare flood.

<u>Nonstructural Measures</u>

Consideration was given to certain nonstructural measures for the protection of homes and commercial property from tidal flooding. As indicated by the former Assistant City Manager, the purchase and demolition or the relocation of homes is not a practical alternative in this area. Little vacant land is available in the immediate vicinity and the cost of its purchase and/or cost of new houses would be prohibitive to many of the people who now reside in low-lying areas and who presently own extremely modest homes. Nevertheless, both the raising of homes and the purchase and demolition thereof were considered.

Several areas were suggested by the former Assistant City Manager for investigation. These were inspected in the field and, as a result, the following areas were investigated in depth:

a. POQ-1 -- primarily a commercial area.

b. POQ-2 -- a trailer court area.

c. POQ-3 -- a typical area of houses of above average value in one of the coves adjoining Poquoson River.

d. POQ-4 -- an area of moderately priced houses typical of the central Poquoson area. It also includes many lower priced homes near Chesapeake Bay and its tributaries. The latter homes are among the lowest in the city. The first floor of many of these homes is below the level of the 25-year tidal flood. Many could be affected by wave action in the 100-year tidal flood.

Table B-6 presents a summary of the nonstructural areas investigated and Figure B-13 shows the areas.

IMPACT ASSESSMENT AND EVALUATION

Any deepening or widening of ditches or improving the drainage conditions would have a major effect on the terrain. Construction of a wall which would encircle a large portion of the city would separate it from adjacent areas. This is not deemed to be in the city's best interest. The raising of numerous residences would have little effect on the environment. However, it could inconvenience the residents during construction. The purchase and demolition of buildings would have a major social effect on the families involved.

TABLE B-6

POQUOSON, VIRGINIA
NONSTRUCTURAL AREAS INVESTIGATED

AREA	AREA DESCRIPTION	RESIDENCES: NUMBER SURVEYED	RESIDENCES: NO. WITH 1st FLOOR BELOW LEVEL OF 100-YEAR FLOOD	RESIDENCES: NO. WITH 1st FLOOR BELOW LEVEL OF 25-YEAR FLOOD	COMMERCIAL ESTABLISHMENTS: NUMBER SURVEYED	COMMERCIAL ESTABLISHMENTS: No. WITH 1st FLOOR BELOW LEVEL OF 100-YEAR FLOOD	COMMERCIAL ESTABLISHMENTS: No. WITH 1st FLOOR BELOW LEVEL OF 25-YEAR FLOOD	TRAILERS: NUMBER SURVEYED	TRAILERS: NO. WITH 1st FLOOR BELOW LEVEL OF 100-YEAR FLOOD	TRAILERS: NO. WITH 1st FLOOR BELOW LEVEL OF 25-YEAR FLOOD
POQ-1	Wythe Creek Road near Hudgins Creek	-	-	-	38	4	0	-	-	-
POQ-2	Trailer Park near intersection of Wythe Creek and Cary's Chapel Roads	96	96	0	-	-	-	96	96	0
POQ-3	Browns Neck Road-West Sandy Point Road - East Sandy Point Road - Phillips Road	46	45	9	-	-	-	-	-	-
POQ-4	Bunting Lane - Lodge Road-Ridge Road-Messick Road-Poquoson Avenue-Church Street	387	377	179	6	6	3	-	-	-

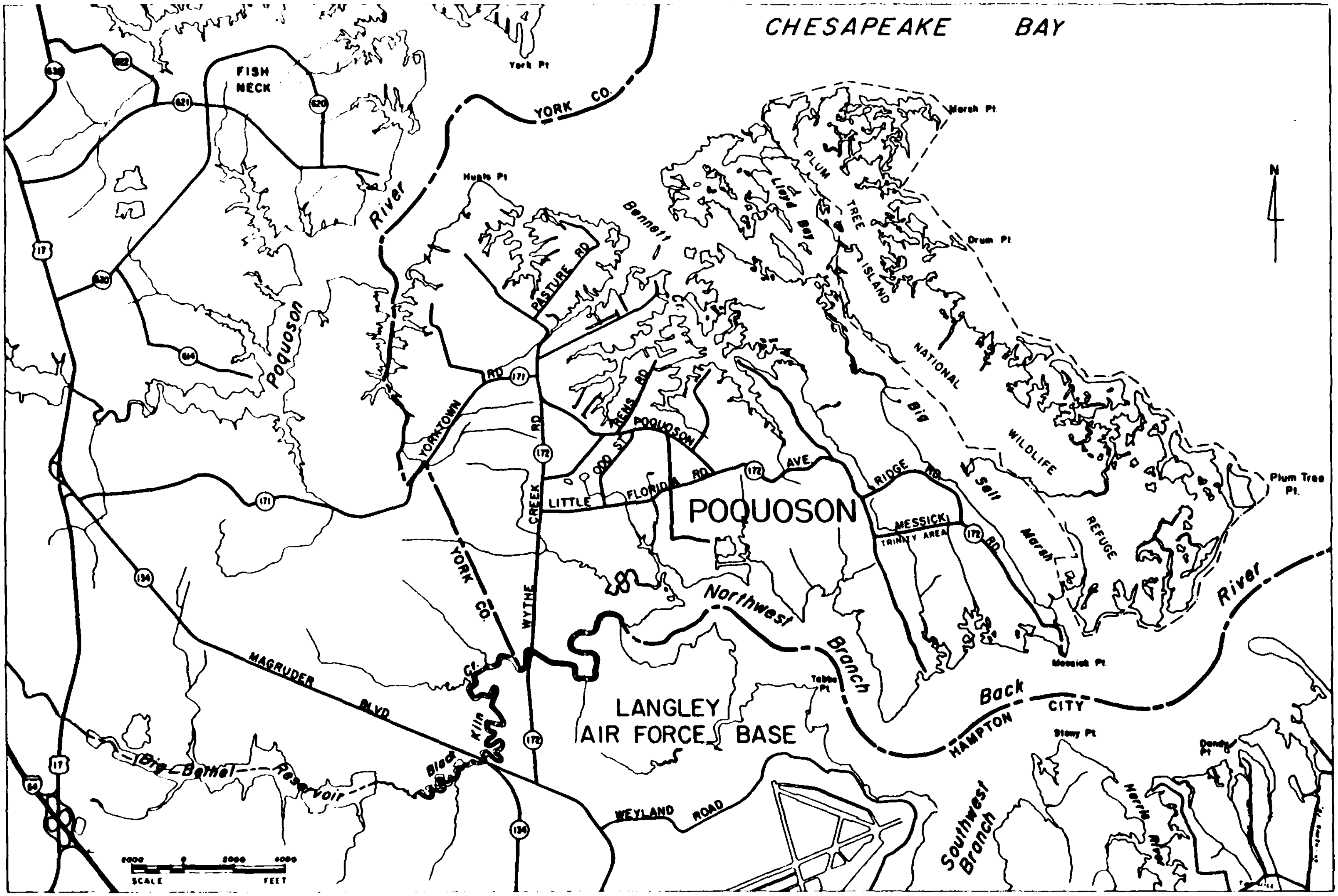


FIGURE B-13 POQUOSON AREAS OF DETAILED STUDY

No environmental and/or biological factors appear to be involved in connection with the raising of houses. There are no existing dunes along the shoreline. Therefore, mitigation due to a deterioration of fish and wildlife and/or factors involving the environment, does not appear to be necessary.

TANGIER ISLAND, VIRGINIA

DESCRIPTION OF PLANS

Tangier has an operational procedure for disasters. It includes a plan which becomes effective when a northeaster and/or hurricane approaches the area. The school on the island has been identified as a shelter. However the roads on the island are at an elevation such that a rare flood would inundate them.

Structural Measures

Consideration was given to the construction of a wall around each of three ridges: West Ridge, Main Ridge, and Canton Ridge - all of which are shown in Figure B-14. Each of these walls would be built to the level of the 100-year tidal flood stage plus three feet of freeboard. Consideration was also given to surrounding either the community center, the school, or church with a concrete wall high enough to provide a location on the island that is protected against a major flood.

Nonstructural Measures

The one nonstructural measure considered was that of raising structures. This is the only nonstructural measure that is practical. Neither acquisition and demolition nor relocation is applicable to Tangier. Usable land is scarce and has been developed.

Several plans for raising the structures were considered using both the Corps frequency and the VIMS frequency curves. Table B-7 lists these plans assuming all structures can be raised.

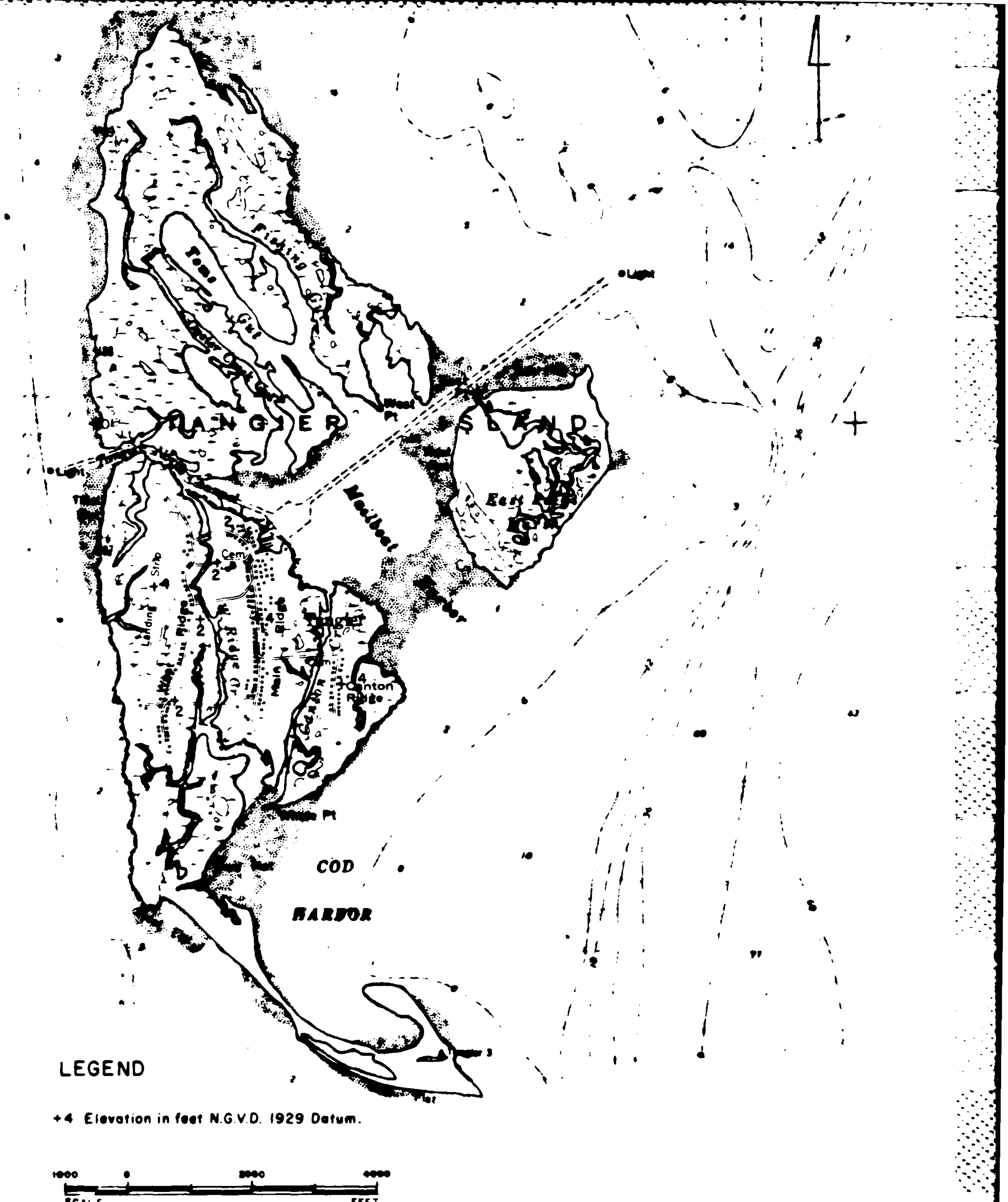


FIGURE B-14 TANGIER ISLAND VICINITY MAP

TABLE B-7

NONSTRUCTURAL MEASURES
CONSIDERED FOR TANGIER, VIRGINIA

PROTECTION TO ELEVATION (NGVD)	FREQUENCY (YEARS)	NONSTRUCTURAL MEASURES CONSIDERED
	ESTIMATES OF FREQUENCY BY CORPS	
8.5	100	Raising 331 structures -- 298 residential units, 26 commercial units, and 7 public units.
7.0	25	Raising 280 structures -- 254 residential units, 20 commercial units, and 6 public units.
	ESTIMATES OF FREQUENCY BY VIMS	
4.1	100	Raising 11 structures -- 6 residential units, and 5 commercial units.

IMPACT ASSESSMENT AND EVALUATION

Any additional structures on Tangier, such as concrete walls, would further reduce the small amount of land available to the islanders. The raising of practically all the houses on Tangier would have a major social and possibly an environmental effect on the community. Undoubtedly construction activities could create side effects on some of the adjacent marshland through litter, the placement of material thereon, and the movement of vehicles.

WEST POINT, VIRGINIA

DESCRIPTION OF PLANS

West Point has no operational procedure for disasters, nor does it have a separate emergency response plan in case a northeaster and/or hurricane approaches the area.

Structural Measures

Structural measures would involve a wall along First Street, portions of Kirby Street parallel to the Pamunkey River for a maximum distance of 2,200 feet, and portions of Lee Street parallel to the Mattaponi River. These areas are shown in Figure B-15. Many of the residences along First Street would have to be relocated. The first floor of 18 of the 43 buildings to be protected to the Corps 100-year elevation of 8.5 feet are only 0.5 feet below this level. Practically all of the buildings are single-family residences and are

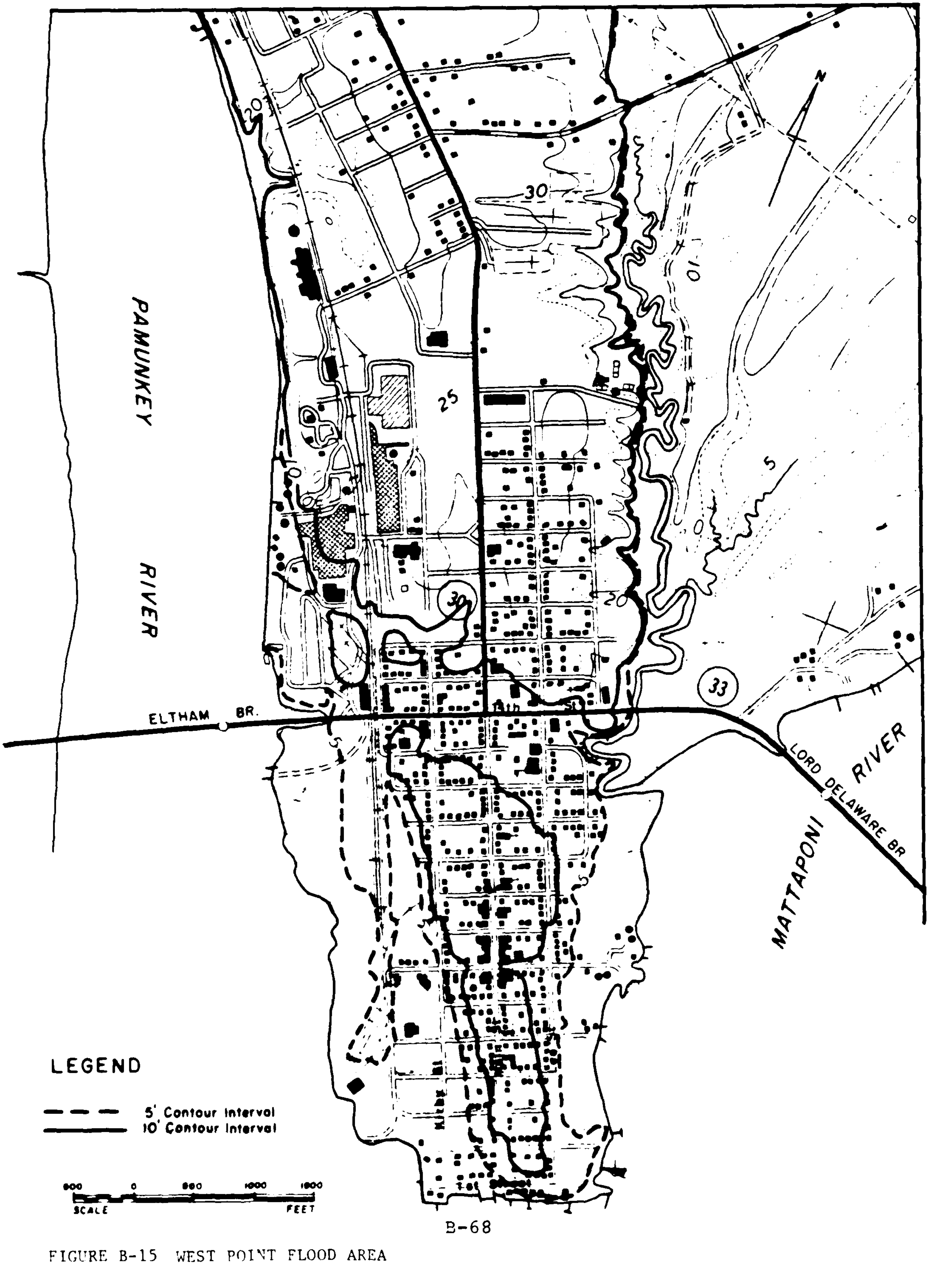


FIGURE B-15 WEST POINT FLOOD AREA

scattered over a distance of 1 mile. The first floor levels of the remaining buildings in West Point are at elevation 10 feet or higher. The 43 buildings are not concentrated into apartment houses or commercial developments. Accordingly, the construction of walls, pumping stations, and closures for the existing buildings is not warranted and was not given further consideration.

In the case of The Chesapeake Corporation, the company would sustain substantial damage from tidal floods. However, it has a program for gradually raising plant and equipment to an elevation of 8 feet. Accordingly, it was believed that no further consideration should be given to protecting the plant. The company was so advised.

Nonstructural Measures

It is believed that the acquisition and demolition of homes or their relocation to another area would not be socially acceptable since many of the buildings have an outstanding view of the waters surrounding the town. In the study area, which includes 15th Street and below, the two basic nonstructural plans considered consist solely of structure raising. These plans are presented in Table B-8.

TABLE B-8

NONSTRUCTURAL MEASURES CONSIDERED FOR WEST POINT, VIRGINIA

PROTECTION TO ELEVATION (NGVD)	FREQUENCY (YEARS)	NONSTRUCTURAL MEASURES CONSIDERED
		BASED ON STAGE-FREQUENCY BY CORPS
8.5	100	Raise 19 structures 0.5 foot Raise 7 structures 1.5 feet Raise 2 structures 2.5 feet Raise 12 structures 3.5 feet Raise 3 structures 4.5 feet
7	25	Raise 2 structures 1 foot Raise 12 structures 2 feet Raise 3 structures 3 feet
		BASED ON STAGE-FREQUENCY BY VIMS
6	100	Raise 12 structures 1 foot Raise 3 structures 2 feet
5	25	Raise 3 structures 1 foot

IMPACT ASSESSMENT AND EVALUATION

A wall along the waterfront would require the removal of many of the houses along First Street and would be socially objectionable. The raising of residences would have little effect on the environment. However it could inconvenience the residents during construction. No environmental and/or biological factors appear to be involved in connection with the raising of houses.

SENSITIVITY ANALYSIS

Certain factors such as mapping, damage estimates, cost estimates, and the engineering feasibilities of the proposed plans were based on preliminary data and will have the potential to change with more detailed investigation. Also, changes in the level of development within the floodplain can and would have a significant effect on the feasibility of the previously discussed structural and nonstructural plans. However, it was determined that the aforementioned factors as well as the effects of the requirements of the Flood Insurance Program (in which all of the communities participate) all have a minimum impact upon the average annual benefit computations.

On the other hand, it was determined that even slight shifts in the stage-frequency information used in this report can and do have a far greater impact on the average annual benefit computations and, in the end, recommendations for further study. As mentioned in Appendix E - Engineering Design and Cost Estimates, stage-frequency information for much of Chesapeake Bay was limited and in order to complete even a preliminary investigation for some communities, certain assumptions needed to be made. It is these adaptations which generated the need for this type of investigation and uncovered the high degree of sensitivity that the benefit computations exhibited to frequency shifts. Therefore, the sensitivity analysis focused primarily on the effects of differing frequency assumptions on the benefit computations and resultant benefit-cost ratios (BCR's).

It should be noted that the shifting of frequency curve relationships for this analysis was not necessarily a concession that the actual curves used are not accurate but merely an acknowledgement that, due to lack of historical data and the variability of storm surges within short distances in Chesapeake Bay, changes in these relationships should not be completely unexpected or unaccounted for. Further development of synthetic data would help to solve this problem in the future.

The following paragraphs summarize, by community, the results of this sensitivity investigation. For those communities for which one frequency curve was established (all of the Maryland communities), the analysis consisted of shifting the frequency relationship 0.5 feet and 1 foot for the same recurrence level (for example, the 100-year flood stage would shift from 6.0 feet to 7.0 feet) and observing the effects on the plan with the best BCR. For those communities for which two differing frequency curves were established (Virginia communities of Cape Charles, Poquoson, Tangier Island and West Point), the sensitivity analysis consisted of a comparison of both sets of benefit computations for all of the plans considered.

CAMBRIDGE, MARYLAND

For the City of Cambridge, nonstructural plan CA-7 exhibited the highest benefit-cost ratio of all plans considered (BCR = 0.52). As shown in Table B-9, shifting the base frequency curve (VIMS @ Cambridge) by 0.5-feet approximately doubled the BCR and made a previously unjustifiable project approach feasibility. Further, a shift of 1.0 feet nearly tripled the original BCR to 1.45. It was therefore concluded that all identified nonstructural projects for Cambridge would be very sensitive to frequency adjustments and that any recommendations for future study should at least consider the impacts of these results.

CRISFIELD, MARYLAND

Plan CR-5 displayed the best BCR of all plans considered for Crisfield (BCR = 0.66). Shifting the base frequency curve (VIMS @ Crisfield) by 0.5 feet increased the BCR to a feasible value of 1.01, as shown in Table B-9. Shifting the curve by 1.0 feet approximately doubled the original BCR to 1.30. Again it was concluded that since the plans investigated did demonstrate a high degree of sensitivity to these shifts, recommendations as to the need for further study in Crisfield should consider these results.

POCOMOKE CITY, MARYLAND

The best BCR of all plans considered for Pocomoke City was that of Plan PC-3 (BCR = 0.53). As shown in Table B-9, shifting the base frequency curve (VIMS @ Guard Shores, Va.) by 0.5 feet increased this plan's BCR to 0.82. A 1.0 foot shift more than doubled the original BCR to a value of 1.20. As was the case with both Cambridge and Crisfield, it was again concluded that because of such large increases in the BCR (from an unjustifiable economic value of 0.53 to a feasible value of 1.20), any recommendation as to the need for further study should at least consider the effects of sensitivity shifts.

ROCK HALL, MARYLAND

For the Town of Rock Hall, nonstructural plan RH-8 displayed the highest benefit-cost ratio of all plans considered (BCR = 0.28). As shown in Table B-9, shifting the base frequency curve (VIMS @ Tolchester) by 0.5 feet, changed the BCR to 0.32. A shift of 1.0 foot raised the BCR to only 0.39. Therefore, it was concluded that the effects of frequency shifts on the plans considered for Rock Hall were minimal.

SNOW HILL, MARYLAND

Plan SH-6 displayed the best BCR of all plans considered in Snow Hill (BCR = 0.16). Shifting the base frequency curve (VIMS @ Guard Shores, Va.) by 0.5 foot, increased the BCR to 0.30, as shown in Table B-9. Shifting the curve by 1.0 foot more than tripled the original BCR to a ratio of 0.56. However, as even this value is far from economic feasibility, it was concluded that sensitivity effects on the plans considered for Snow Hill were minimal.

TABLE B-9

RESULTS OF SENSITIVITY ANALYSIS ON BCR'S
FOR MARYLAND COMMUNITIES

Frequency Assumpt.	Cambridge Plan CA-7 (Protection to 5' NGVD)	Crisfield Plan CR-5 (Protection to 4' NGVD)	Pocomoke City Plan PC-3 (Protection to 5' NGVD)	Rock Hall Plan RH-8 (Protection to 6' NGVD)	Snow Hill Plan SH-6 (Protection to 6' NGVD)	St. Michaels Plan SM-4 (Protection to 7' NGVD)	Tilghman Plan TI-5 (Protection to 4' NGVD)
Base Cond.	0.52	0.66	0.53	0.28	0.16	0.16	0.28
1/2-foot shift	0.97	1.01	0.82	0.32	0.30	0.28	0.39
1-foot shift	1.45	1.30	1.20	0.39	0.56	0.41	0.66

ST. MICHAELS, MARYLAND

The best BCR of all plans considered for St. Michaels was that of Plan SM-4 (BCR = 0.16). As shown in Table B-9, shifting the base frequency curve (VIMS @ Matapeake) by 0.5 foot changed the BCR to 0.28. A shift of 1.0 foot raised the BCR to only 0.41. Therefore it was concluded that the effects of frequency shifts on the plans considered for St. Michaels were minimal.

TILGHMAN ISLAND, MARYLAND

For the Tilghman Island area, nonstructural plan TI-5 displayed the highest benefit-cost ratio of all plans considered (BCR = 0.28). Shifting the base frequency curve (VIMS @ Chesapeake Beach) by 0.5 feet increased the BCR to 0.39, as shown in Table B-9. Shifting the curve by 1.0 foot more than doubled the original BCR to 0.66. However, as even this value is far from economic feasibility, it was concluded that sensitivity effects on the plans considered for Tilghman Island were minimal.

CAPE CHARLES, VIRGINIA

The stage-frequency curve established for Cape Charles was determined in connection with the preparation of the flood plain information report for this community. The report by the Virginia Institute of Marine Science (VIMS) contains a stage-frequency relationship in the vicinity of this community (Eastville, Va.) that is lower than that used in this report. Use of the VIMS study data would further reduce the net benefits and economic feasibility of the tidal flood protection plans considered. The FIA has adopted the stage-frequency analyses developed by the Corps for this community.

HAMPTON ROADS, VIRGINIA

For the areas investigated, the stage-frequency curves are deemed to be reasonable. Cost estimates have been updated and are believed to be reasonable. At this time, it is believed that the economic feasibility study would not be modified materially due to these or other factors.

POQUOSON, VIRGINIA

The stage-frequency curve established for Poquoson was determined in connection with the preparation of the flood plain report for this community. The 100-year tidal flood was estimated to be at elevation 8.5 feet. By comparison, a study by VIMS estimates the elevation of the 100-year tidal flood to vary from 7.7 feet in the area bordering the Poquoson River to 8.5 feet in the area bordering Back River. Both of these studies account for stillwater elevations only. A revised flood insurance study, published in August 1983, took into account wave action. This study estimated the elevation of the 100-year tidal flood to range from 9.0 feet to 13.0 feet because of wave action. The new flood insurance study is based on the stillwater elevations in the VIMS Study. The City of Poquoson has expressed objections to the new study and is preparing its appeal. According to the city, there has been a lack of wave action in past storms. Therefore, the city believes that Plum Tree Island would serve as a barrier to wave action during a major storm.

TANGIER ISLAND, VIRGINIA

In June 1978, the Virginia Institute of Marine Science prepared a report on storm surge heights and frequency analysis for Chesapeake Bay. It estimated the 100-year tidal flood stage at Tangier to be elevation 4.1 feet. The report was accomplished for the Federal Insurance Administration which has since adopted the results for the area along Chesapeake Bay except at Cape Charles, Virginia.

The Norfolk District Corps of Engineers developed a frequency curve for the lower reaches of Chesapeake Bay, establishing a stillwater elevation for the 100-year flood level at 8.5 feet referred to the National Geodetic Vertical Datum (NGVD). A study performed by the Baltimore District and published in House Document 350, Eighty-Eighth Congress, Second Session, printed 19 August 1964, established an elevation of 8.6 feet referred to mean low water for the 100-year flood. This curve was applicable to the Patuxent, Potomac, and Rappahannock Rivers including adjacent Chesapeake Bay shoreline. This is equivalent to 7.0 to 8.0 NGVD at the upper portion of Chesapeake Bay in the vicinity of the Maryland-Virginia state line.

Systematic recording gages around Chesapeake Bay are meager. Therefore, the determination of the frequency of tidal flooding for the vast reaches of the Bay are approximate. The Hampton Roads gage, with its 75 years of record, produces a well-defined frequency curve for the lower reach of the Bay. The Potomac River frequency is fairly well defined by tide records at Washington, D.C. and the U.S. Naval Weapons Laboratory at Dahlgren, Virginia. Using frequency curves developed from these gages, high water marks, newspaper accounts, and interviews with residents throughout the area, an elevation of 8.5 feet referred to the mean sea level datum was selected for the elevation of the 100-year flood.

The physical characteristics and exposure of each location and variation in wind pattern and movement of a storm produce different stages throughout the Bay. A marked difference in stage in a given storm will occur on the eastern and western sides of the Bay and also between the shoreline and head of an estuary. Therefore, it is acknowledged that the use of a constant stage throughout the lower Bay area is approximate, but it is deemed satisfactory for this stage of study. Further studies must be made to firmly establish the frequency of flooding throughout Chesapeake Bay.

WEST POINT, VIRGINIA

A stage-frequency curve for West Point has not been established. A comparison has been made between the Corps frequency curve at Poquoson and the VIMS curve for Gloucester Point as shown in Table B-10. Evidently, the August 1933 high water mark and the Corps data for Garden Creek north of Gloucester confirm that the 100-year flood is one approaching elevation 8.5 feet. Nevertheless, VIMS frequency analysis for Gloucester Point has been included in the study to determine its effect on the economic justification for protective works at West Point. As was the case with all of the other Virginia communities where VIMS data were compared with historical data, there was a reduction in net benefits and, in most instances, the overall economic feasibility of the flood protection plans considered.

TABLE B-10

STAGE-FREQUENCY DATA COMPARISON FOR WEST POINT, VIRGINIA

PROBABILITY IN YEARS	STAGE, REFERRED TO MEAN SEA LEVEL BASED ON FREQUENCY DATA BY	
	CORPS	VIMS
100	8.5	5.9
60	8	-
50	-	5.4
25	7	-
10	-	4.6
6	5	-

SUMMARY OF FINDINGS

In order to create a format conducive to comparative assessment and evaluation, the tables in Annex B-1 were developed. Using information not only from this appendix but also from Appendix E - Engineering Design and Cost Estimates and Appendix F - Economics, Tables B-1-1 through B-1-12 were compiled to serve as both a summary and a System of Accounts presentation.

Obviously those plans which show BCR's equal to or greater than 1.0 should be considered for further study. However, due to the nature of some of the data, plans with BCR's less than 1.0 may have been considered for further study if it was felt there was potential for either reducing the cost and/or increasing the benefits of the plans. Conversely, plans with BCR's greater than 1.0 may not have been considered if it was felt that more detailed investigations would only result in higher costs and much lower BCR's. The following paragraphs summarize, by community, the results of the investigations and any evaluations made as to the necessity for further investigation.

CAMBRIDGE, MARYLAND

As shown in Table B-1-1, the structural plans investigated for Cambridge (Plans CA-1 through CA-6) lacked both economic feasibility and social acceptability. Therefore, no further structural investigation is warranted for Cambridge. Nonstructural protection plans (Plans CA-7 and CA-8), although higher in economic justification than the structural plans, also did not approach a level of feasibility (BCR = 0.52 and 0.37) to recommend further investigation. However, given the results of the sensitivity analysis it is appropriate to consider more detailed investigation of nonstructural alternatives if and when more definitive stage-frequency information dictates the need.

CRISFIELD, MARYLAND

Structural protection for Crisfield (Plans CR-1 through CR-4) clearly was not economically justified as shown in Table B-1-2. Of the two nonstructural plans, only Plan CR-5 (BCR = 0.66) was considered to have potential for further study. Nevertheless, it was felt that detailed study would only result in higher costs and a lower BCR. As was the case with Cambridge, however, a shift in the frequency relationship did substantially

improve the BCR for Plan CR-5. Therefore, while no further nonstructural investigation is recommended, future consideration should be given to nonstructural improvements in Crisfield if a revised stage-frequency relationship is substantially different than the one used in this study.

POCOMOKE CITY, MARYLAND

Structural protection for Pocomoke City (Plans PC-1 and PC-2) as shown in Table B-1-3 does not, regardless of design height, appear to have any economic justification and is not recommended for further study. Nonstructural Plans PC-4 and PC-5 also do not appear to be reasonably close to economic feasibility to recommend further study. Plan PC-3 (nonstructural protection to the 25-year event) displayed a 0.53 BCR and, while it was the highest in economic justification, it did not warrant further study. However, the results of the sensitivity analysis indicated that if the stage-frequency curve were to shift as much as 0.5 to 1.0 feet, Plan PC-3 would be justified. Consequently, it is felt that further investigation of nonstructural measures for Pocomoke City be delayed until such time that better stage-frequency information is made available which would show a substantial difference from the curve used for this study.

ROCK HALL, MARYLAND

As shown in Table B-1-4, none of the structural or nonstructural plans proposed approach economic justification enough to warrant further study at this time. The highest BCR was 0.28, for nonstructural Plans RH-7 and RH-8. It was felt that a more rigorous investigation of these plans would only increase the costs and, therefore, the plans were dropped from further consideration. In addition, the results of the sensitivity analysis showed that all of the plans considered were not sensitive to even a 1.0 foot shift in the frequency curve. Therefore, future consideration of these plans for the Town of Rock Hall is also not warranted.

SNOW HILL, MARYLAND

Both structural and nonstructural plans of protection for Snow Hill presented in Table B-1-5 appear to have little justification for further investigation. With Plan SH-6 having the highest BCR (0.16) there is little likelihood that any plan would be feasible, both now and in the future. Furthermore, substantial shifts (up to 1.0 foot) in the stage-frequency relationships were shown to have little effect on the BCR. Hence, there is no recommendation for further study of the Town of Snow Hill.

ST. MICHAELS, MARYLAND

All of the plans investigated for St. Michaels, shown in Table B-1-6, were far below the limit at which a recommendation for further study can be made. BCR's of 0.15 and 0.16 (Plans SM-3 and SM-4) were the highest for all plans and it was felt that further investigation would only reduce these numbers by increasing the costs. As with Rock Hall and Snow Hill, shifts in the frequency curves had no perceptible effect on the BCR. Thus, no further structural or nonstructural investigations for St. Michaels are recommended.

TILGHMAN ISLAND, MARYLAND

The structural and nonstructural plans investigated for Tilghman Island did not have BCR's approaching 1.0 and, correspondingly, there is no recommendation for further study. Of all of the plans identified, only Plan TI-5, presented in Table B-1-7, had a BCR as high as 0.28 which is not worthy of more detailed investigation. Sensitivity computations also indicated no great effect on the BCR and therefore future consideration of the proposed structural or nonstructural plans of protection for Tilghman Island is not warranted.

CAPE CHARLES, VIRGINIA

Table B-1-8 summarizes the structural and nonstructural plans considered for Cape Charles. Structural improvement at the existing bulkhead has been completed by the Soil Conservation Service (SCS). Further tidal protection may be affected by dikes on the north and south sides of the town and the installation of flap gates in the concrete sewer drains. However, no costs were estimated for these measures. Such nonstructural measures as the raising of existing buildings and/or the transfer of mechanical and electrical equipment from the basement of buildings to a first-floor utility room addition (Plans A through D) are not economically justified.

HAMPTON ROADS, VIRGINIA

Table B-1-9 summarizes the structural and nonstructural plans investigated for the Fox Hill area of Hampton Roads. Although the plans in the table offer some insight as to the feasibility of both structural and nonstructural alternatives, the preliminary investigation made for Fox Hill is not sufficient to offer conclusive evidence of the economic feasibility of tidal flood protection based on today's level of residential, commercial and industrial development in the entire Hampton Roads city complex. Further comprehensive consideration of both structural and nonstructural measures for the protection of the Hampton Roads city complex - Norfolk, Portsmouth, Chesapeake, and Hampton - from tidal flooding is therefore warranted.

POQUOSON, VIRGINIA

As shown in Table B-1-10, none of the plans except one in POQ-3, exceed the requirements for economic feasibility. However, only a segment of Poquoson has been sampled to determine the desirability of further investigations relative to the justification of nonstructural measures by the Corps. While it is believed that one of the more seriously affected areas has been investigated, further detailed studies of this and other areas will have to be made to obtain a comprehensive understanding of the entire tidal flood situation at Poquoson, particularly in view of the low-lying terrain and the potential for loss of life.

TANGIER ISLAND, VIRGINIA

Table B-1-11 displays the data prepared on the structural and nonstructural plans considered for Tangier Island. No benefit-cost ratio is presented for the construction of a wall around the school building since this is considered a must to ensure a safe refuge for the people in the community. The benefit-cost ratio for the plan using the VIMS' 100-

year frequency is favorable but only affects 11 structures. The two plans using the Corps frequency are not economically justified. However there is no benefit to be calculated for the safety and/or lives of the population in the event that the waters of a major tidal storm overtop the island to a considerable depth. Escape to the mainland by boat, helicopter, or plane would not be practical.

WEST POINT, VIRGINIA

Structural protection for West Point is not deemed feasible. As shown in Table B-12, the raising of only three residential structures is warranted under the VIMS 25-year flood level.

ADDITIONAL OBSERVATIONS

As a result of the tidal flooding analysis conducted during the Chesapeake Bay Study, several more observations are noteworthy. Tidal flooding is a problem that periodically affects all of Chesapeake Bay's shorelines at one time or another. Based on the screening criteria, sixty Bay communities were identified as having existing or potentially serious tidal flooding problems. Less obvious, perhaps is that significant monetary loss resulting from tidal flooding is incurred by only a few of these sixty communities which, because of topography and land use patterns, are especially susceptible to damage in developed sections.

Both structural and nonstructural measures were considered for preventing or reducing the adverse effects of tidal flooding in the 12 communities examined in detail. Structural measures usually impact adversely on the environment and are expensive. Furthermore, residents dislike structural measures for aesthetic reasons and because direct and easy access to the Bay shoreline may be hindered. Nonstructural measures, on the other hand, are less damaging to the environment and are, usually, less expensive. However, to make a nonstructural tidal flood protection program effective on a community-wide basis, voluntary participation by nearly all residents and businesses is required. Furthermore, these solutions usually require direct monetary outlays by the participants.

Economic information developed during the Tidal Flooding Study indicated that protection programs were economically justified in only a few communities. Of the 12 communities investigated only some of the plans formulated for Poquoson, Tangier Island, and West Point were found to have benefit-cost ratios greater than 1.0. The value and intensity of development in most flood-prone areas was not great enough to warrant a full-scale tidal flooding program. An additional observation is that many residents of flood-prone communities view tidal flooding as a temporary inconvenience which is a tolerable trade-off for the convenience of living and working close to the waters of Chesapeake Bay.

Although flood protection plans for the Town of Cape Charles and the Hampton Roads city complex are not justified, several findings did result from the analysis of these areas. The ground level on the north and south sides of Cape Charles should be raised to the level of the existing bulkhead with flapgates installed in the storm drains.

Existing flood damage surveys in the Hampton Roads area are over 20 years old, and much new development along with substantial redevelopment has occurred in this particular area. Therefore, further studies of the Hampton Roads City complex should be made to ascertain the economic feasibility of structural and/or nonstructural measures.

This should take into account the effect of wave action and runup, particularly in the exposed areas adjoining Chesapeake Bay and its estuaries. The increase in development during the last 20 years, since completion of the 1963 study, warrants a restudy. Emphasis should be placed on all factors-economic, environmental, social, and technological. Furthermore, city officials throughout the Hampton Roads City complex should insure that the first floor level of the numerous evacuation shelters are sufficiently reinforced and at an elevation so as to protect occupants from a major catastrophic flood including the effect of wave action. The Corps of Engineers should assist in this matter if so requested by local officials.

The analysis of Poquoson indicated that one plan for tidal flooding protection has a benefit-cost ratio of 1.0 or better. Because of the extent and seriousness of its tidal flood problem, the Corps of Engineers should prepare a detailed feasibility investigation of the entire city to establish the seriousness and extent of the tidal flood problem, the need and justification for the evacuation of individual houses from the flood plain particularly those that are in serious jeopardy, the justification for low levees or walls for individual and/or small groups of houses, the raising of escape roads during high water, and the desirability of an urban renewal program in the extremely low-lying areas which FIA indicates are subject to major wave action. Consideration should also be given to floodproofing the Middle School or another building wherein the public could congregate in the event of a major flood. The building should be floodproofed or protected by a wall to a high level of protection.

The analysis of Tangier Island indicated that a definite stage-frequency relationship does not exist. A stage-frequency analysis of Chesapeake Bay should be conducted based on a numerical tidal surge model developed by the U.S. Waterways Experiment Station at Vicksburg, Mississippi. This should be coordinated with the Federal Insurance Administration and the Virginia Institute of Marine Science so that the stage-frequency analysis for Tangier can be resolved. Further studies should then be made of structural and/or nonstructural protection measures based on the results of the frequency analysis referred to above. This would be particularly desirable due to the isolation of the population from the mainland. Consideration should also be given to floodproofing the Tangier School or another public building wherein the public could take shelter in the event of a major flood. The building should be floodproofed to a high level of protection.

Another finding that is common to all of the Virginia communities is that the Commonwealth of Virginia, with the assistance of the Corps and local officials including the civil defense coordinator, insure that concrete or metal markers be placed to indicate to the public the height of future floods.

Given the lack of historical tidal floodstage and frequency information, a coordinated program should be instituted to collect and record stage-frequency data. This program should include appropriate state agencies as well as Federal agencies such as the Corps of Engineers, the Coastal Zone Agency of the National Oceanographic and Atmospheric Administration, the Federal Emergency Management Agency, the National Weather

Service, and other appropriate agencies. This program should not limit its scope to the communities examined in this study but should be Bay-wide in nature. Thus an effective Bay-wide data base can be established which will be of great benefit in the future evaluation of tidal flooding.

As much still is to be learned about the intricacies of natural events which result in tidal flooding, the completion of a storm-surge model would be beneficial. A model of this type would permit more accurate forecasts of tidal flooding stages. A storm-surge model would also be useful in developing better stage-frequency relationships on which to base the economic evaluation of flood protection plans. A model of this nature, if developed to represent surges Bay-wide could be of much benefit to all of the tidal communities.

Despite the fact that few of the plans for tidal flood protection are justified, steps can be taken to reduce inconvenience and damage in any community. Perhaps one of the most promising measures is the coordinated development of an accurate tidal flood forecasting and warning system. A measure of this type could be developed through the efforts of the National Weather Service and state and local civil defense and disaster preparedness departments. Included in a flood forecasting and warning system could be items such as: 1) advance weather and tidal stage forecasts, 2) communication networks to inform communities and residents of potential flooding, 3) permanent markers placed in critical areas to indicate tidal flood heights, 4) identification of low-lying areas and planned evacuation routes from these same areas, and 5) designation of municipal buildings out of the flood-prone areas for temporary shelter during flood events. While these actions will not reduce the incidence or magnitude of tidal flooding, inconvenience, physical damage, and personal injury may be reduced.

It is recognized that many residents of flood-prone communities view tidal flooding as a temporary inconvenience which is traded off against the aesthetics and benefits of living and working near the Chesapeake Bay. It is also recognized that development in some of these areas may be faster than in others attracting residents who may view tidal flooding as a problem rather than as an inconvenience. Through the use of comprehensive planning documents, land use designations, and zoning ordinances, prudent use should be made of flood-prone areas in such a way as to minimize the loss that may result from future tidal flooding events.

ANNEX B-1

COMPARATIVE ASSESSMENTS AND EVALUATIONS

COMMUNITIES UNDER STUDY

TABLE B-1-1

COMPARATIVE ASSESSMENT AND EVALUATION
CAMBRIDGE, MARYLAND

STUDY OBJECTIVE	PLAN	DESCRIPTION OF PLAN	BENEFICIAL EFFECTS	ADVERSE EFFECTS	ECONOMICS
Reduce flood damages in Cambridge.	Plan CA-1 Map Ref A-D	15,500 feet of levee/wall which runs along a portion of the southern bank of the Choptank River from the city's western limits (Pink's Pond) eastward; including Cambridge Creek and ending near the Port Commission Terminal (6' NGVD design elev.).	Will reduce flood hazard and provide degree of protection indicated for the portion of Cambridge within the City limits.	Destruction of fringe marsh areas scattered around the shores of Cambridge Creek (10 acres). Approximately six acres of wetland type #17 (irregularly flooded salt marsh) will be cut off by construction of flood wall/levee resulting in eventual destruction. Less than five acres of marsh will be affected due to construction near Gray Marsh. Temporary destruction of benthic organisms due to construction. Recolonization may occur after completion of construction. Some permanent loss of habitat may also occur. Increased siltation and turbidity which may effect submerged aquatic vegetation and fish. Use of shoreline will be restricted and access to existing piers and wharves difficult. Adverse effects to the aesthetic conditions of the area.	D.O.P. = 120-year F.C. = $7,588,000 A.A.C. = $587,000 A.A.B. = $85,500 B.C.R. = 0.14
Reduce flood damages in Cambridge.	Plan CA-2 Map Ref B-D	11,400 feet of levee/wall which begins near Mill St. and includes the municipal boat basin and Cambridge Creek ending near the Port Commission Terminal (6' NGVD design elev.).	Will reduce flood hazard and provide degree of protection indicated for the area of Cambridge Creek and the municipal boat basin only.	Same as above.	D.O.P. = 120-year F.C. = $5,869,200 A.A.C. = $454,000 A.A.B. = $65,900 B.C.R. = 0.14
Reduce flood damages in Cambridge.	Plan CA-3 Map Ref C-D	9,700 feet of levee/wall which begins near High St., includes Cambridge Creek and ends near the Port Commission Terminal (6' NGVD design elev.).	Will reduce flood hazard and provide degree of protection indicated for the area of Cambridge Creek only.	Same as above.	D.O.P. = 120-year F.C. = $5,156,400 A.A.C. = $399,600 A.A.B. = $57,300 B.C.R. = 0.14

D.O.P. = Degree of Protection
F.C. = First Cost
A.A.C. = Average Annual Cost
A.A.B. = Average Annual Benefit
B.C.R. = Benefit-Cost Ratio

TABLE B-1-1 (Cont'd)

COMPARATIVE ASSESSMENT AND EVALUATION
CAMBRIDGE, MARYLAND

STUDY OBJECTIVE	PLAN	DESCRIPTION OF PLAN	BENEFICIAL EFFECTS	ADVERSE EFFECTS	ECONOMICS
Reduce flood damages in Cambridge.	Plan CA-4 Map Ref A-D	15,625 feet of levee/wall which runs along a portion of the southern bank of the Choptank River from the city's western limits (Pink's Pond) eastward; including the municipal boat basin and Cambridge Creek areas and ending near the Port Commission Terminal (8' NGVD design elev.).	Will reduce flood hazard and provide degree of protection indicated for the portion of Cambridge within the city limits.	Same as above.	D.O.P. = Stand. Project Flood F.C. = $9,120,600 A.A.C. = $706,700 A.A.B. = $103,800 B.C.R. = 0.15
Reduce flood damages in Cambridge.	Plan CA-5 Map Ref B-D	11,550 feet of levee/wall which begins near Mill St. and includes the municipal boat basin and Cambridge Creek areas ending near the Port Commission Terminal (8' NGVD design elev.).	Will reduce flood hazard and provide degree of protection indicated for the area of Cambridge Creek and the municipal boat basin only.	Same as above.	D.O.P. = Stand. Project Flood F.C. = $7,028,400 A.A.C. = $545,000 A.A.B. = $79,200 B.C.R. = 0.14
Reduce flood damages in Cambridge.	Plan CA-6 Map Ref C-D	9,850 feet of levee/wall which begins near High St., includes Cambridge Creek and ends near the Port Commission Terminal (8' NGVD design elev.).	Will reduce flood hazard and provide degree of protection *indicated for the area of Cambridge Creek* only.	Same as above.	D.O.P. = Stand. Project Flood F.C. = $6,061,200 A.A.C. = $469,900 A.A.B. = $67,200 B.C.R. = 0.14
Reduce flood damages in Cambridge.	Plan CA-7	Nonstructural protection to the 5' NGVD (40-year) flood level; includes utility addition, standard floodproofing and floodproofing by floodwall.	Will reduce flood hazard and provide degree of protection indicated for the entire community.	Construction of small floodwalls may result in adverse environmental effects such as destruction of adjacent wetland areas, increased siltation and turbidity and destruction of benthic organisms. Use of shoreline will be restricted and access to existing piers and wharves difficult.	D.O.P. = 40-year F.C. = $356,300 A.A.C. = $26,200 A.A.B. = $13,500 B.C.R. = 0.52
Reduce flood damages in Cambridge.	Plan CA-8	Nonstructural protection to the 6' NGVD (120-year) flood level; includes utility addition, acquisition and demolition, standard floodproofing and floodproofing by floodwall.	Will reduce flood hazard and provide degree of protection indicated for the entire community.	Same as above.	D.O.P. = 120-year F.C. = $749,150 A.A.C. = $55,150 A.A.B. = $20,200 B.C.R. = 0.37

TABLE B-1-2

COMPARATIVE ASSESSMENT AND EVALUATION
CRISFIELD, MARYLAND

STUDY OBJECTIVE	PLAN	DESCRIPTION OF PLAN	BENEFICIAL EFFECTS	ADVERSE EFFECTS	ECONOMICS
Reduce flood damages in Crisfield.	Plan CR-1 Map Ref A-C	22,600 feet of levee/wall beginning at high ground near Jacksonville Road and running along the shoreline to exclude Somer's Cove and tie-out at high ground near Johnson Creek Road. (5' NGVD design elev.)	Will reduce flood hazard and provide degree of protection indicated for most of Crisfield and the surrounding area.	Destruction of fringe marsh areas near Woodson High School (< 5 acres), near Collins Street west of Main Street, (< 10 acres) and west of Wynnfall Ave. (< 20 acres) Destruction of marsh area west of Jacksonville Road to the site of construction (< 25 acres). Temporary destruction of benthic organisms due to construction. Recolonization may occur after completion of construction. Some permanent loss of habitat may also occur. Increased siltation and turbidity due to construction which may effect submerged aquatic vegetation and fish. Use of shoreline will be severely restricted. Adverse effects to the aesthetic conditions of the area.	D.O.P. = 80-year F.C. = $7,018,000 A.A.C. = $543,100 A.A.B. = $145,700 B.C.R. = 0.27
Reduce flood damages in Crisfield.	Plan CR-2 Map Ref A-C	23,300 feet of levee/wall with identical alignment as Plan CR-1. Degree of protection increases to 400-year recurrence level. Additional levee sections are needed to tie into higher ground. (6' NGVD design elev.)	Will reduce flood hazard and provide degree of protection indicated for most of Crisfield and the surrounding area.	Same as above.	D.O.P. = 400-year F.C. = $7,333,200 A.A.C. = $567,200 A.A.B. = $172,000 B.C.R. = 0.30
Reduce flood damages in Crisfield.	Plan CR-3 Map Ref A-B	20,900 feet of levee/wall beginning at high ground near Outten Road and running along the shoreline to exclude Somer's Cove and tie out at high ground near the intersection of Johnson Creek Rd. and Rt. 380 (5' NGVD design elev.).	Will reduce flood hazard and provide degree of protection indicated for most of Crisfield and the surrounding area.	Same as above except excluding destruction of marsh area near Jacksonville Road.	D.O.P. = 80-year F.C. = $5,807,400 A.A.C. = $449,100 A.A.B. = $128,300 B.C.R. = 0.29

TABLE B-1-2 (Cont'd)

COMPARATIVE ASSESSMENT AND EVALUATION
CRISFIELD, MARYLAND

STUDY OBJECTIVE	PLAN	DESCRIPTION OF PLAN	BENEFICIAL EFFECTS	ADVERSE EFFECTS	ECONOMICS
Reduce flood damages in Crisfield.	Plan CR-4 Map Ref A-B	21,650 feet of levee/wall with identical alignment as Plan CR-3. Degree of protection increases to 400-year recurrence level. Additional levee sections are needed to tie into higher ground. (6' NGVD design elev.)	Will reduce flood hazard and provide degree of protection indicated for most of Crisfield and the surrounding area.	Same as plan CR-3.	D.O.P. = 400-year F.C. = $7,215,000 A.A.C. = $558,200 A.A.B. = $164,200 B.C.R. = 0.29
Reduce flood damages in Crisfield	Plan CR-5	Nonstructural protection to the 4' NGVD (12-year) flood level; includes utility addition, acquisition and demolition, trailer relocation, structure raising, standard floodproofing, and floodproofing by floodwalls.	Will reduce flood hazard and provide degree of protection indicated for entire community.	Loss of unique social life style for those that are relocated. Construction of floodwall may result in adverse environmental effects such as destruction of adjacent wetland areas, increased siltation and turbidity, and destruction of benthic organisms. Use of shoreline will be restricted. Adverse effects to the aesthetic conditions of the area. Temporary *noise pollution*.	D.O.P. = 12-year F.C. = $676,300 A.A.C. = $49,800 A.A.B. = $33,000 B.C.R. = 0.66
Reduce flood damages in Crisfield.	Plan CR-6	Nonstructural protection to the 5' NGVD (80-year) flood level; includes utility addition, acquisition and demolition, trailer relocation, structure raising, standard floodproofing and floodproofing by floodwall.	Will reduce flood hazard and provide degree of protection indicated for entire community.	Same as above.	D.O.P. = 80-year F.C. = $6,294,300 A.A.C. = $463,300 A.A.B. = $158,600 B.C.R. = 0.34

TABLE B-1-3

COMPARATIVE ASSESSMENT AND EVALUATION
POCOMOKE CITY, MARYLAND

STUDY OBJECTIVE	PLAN	DESCRIPTION OF PLAN	BENEFICIAL EFFECTS	ADVERSE EFFECTS	ECONOMICS
Reduce flood damages in Pocomoke City	Plan PC-1 Map Ref A-B	10,190 feet of levee/wall which runs along the eastern banks of the Pocomoke River south of the Rt. 13 Bridge. (6' NGVD) design elev.)	Will reduce flood hazard and provide degree of protection indicated for the portion of Pocomoke City south of the Rt. 13 Bridge.	Impact on the wooded wetland areas on the shore at the end of Laurel Street and northwest of Quinn Avenue (total area 10 acres). Temporary destruction of benthic organisms due to construction. Recolonization may occur after completion of construction. Some permanent loss of habitat may also occur.	D.O.P. = 70-year F.C. = $3,542,600 A.A.C. = $274,800 A.A.B. = $11,000 B.C.R. = 0.04
Reduce flood damages in Pocomoke City	Plan PC-2 Map Ref A-B	10,500 feet of levee/wall which runs along the eastern banks of the Pocomoke River south of the Rt. 13 Bridge (8' NGVD design elev.).	Will reduce flood hazard and provide degree of protection indicated for the portion of Pocomoke City south of the Rt. 13 Bridge.	Same as above.	D.O.P. = stand. project flood F.C. = $4,322,700 A.A.C. = $335,300 A.A.B. = $16,600 B.C.R. = 0.05
Reduce flood damages in Pocomoke City	Plan PC-3	Nonstructural protection to the 5' ngvd (25-year) flood level; includes utility relocation, acquisition and demolition, and floodproofing by floodwall.	Will reduce flood hazard and provide degree of protection indicated for entire community.	Construction of floodwall may result in adverse environmental effects such as destruction of adjacent wetland areas, increased siltation and turbidity, and destruction of benthic organisms. Use of shoreline will be restricted. Adverse effects to the aesthetic conditions of the area. Temporary noise pollution.	D.O.P. = 25-year F.C. = $259,700 A.A.C. = $19,100 A.A.B. = $10,100 B.C.R. = 0.53
Reduce flood damages in Pocomoke City	Plan PC-4	Nonstructural protection to the 6' NGVD (70-year) flood level; includes utility relocation, structure raising, trailer relocation, acquisition and demolition, standard floodproofing, and floodproofing by floodwall.	Will reduce flood hazard and provide degree of protection indicated for entire community.	Same as above with the addition of loss of unique social lifestyle for those that are relocated.	D.O.P. = 70-year F.C. = $728,500 A.A.C. = $53,600 A.A.B. = $13,000 B.C.R. = 0.24
Reduce flood damages in Pocomoke City	Plan PC-5	Nonstructural protection to the 7' NGVD (220-year) flood level; includes utility relocation, structure raising, trailer relocation, acquisition and demolition, standard floodproofing and floodproofing by floodwall.	Will reduce flood hazard and provide degree of protection indicated for entire community.	Same as above.	D.O.P. = 220-year F.C. = $1,357,200 A.A.C. = $99,900 A.A.B. = $18,000 B.C.R. = 0.18

TABLE B-1-4

COMPARATIVE ASSESSMENT AND EVALUATION
ROCK HALL, MARYLAND

STUDY OBJECTIVE	PLAN	DESCRIPTION OF PLAN	BENEFICIAL EFFECTS	ADVERSE EFFECTS	ECONOMICS
Reduce flood damages in Rock Hall.	Plan RH-1 Map Ref A-E	22,400 feet of levee/wall "ringing" the Rock Hall-Gratitude areas (9' NGVD design elev.).	Will reduce flood hazard and provide degree of protection indicated for both Rock Hall and Gratitude.	Destruction of marsh areas along the shoreline in Rock Hall Harbor (< 2 acres) northwest of Windmill Point (< 20 acres) and east of Rock Hall Harbor (< 10 acres). A portion of the marsh areas in Gratitude near the Havens will be destroyed due to construction (< 20 acres). Use of shoreline will be severely restricted and access to existing piers and wharves difficult. Temporary destruction of benthic organisms due to construction. Recolonization may occur after completion of construction. Some permanent loss of habitat may also occur. Increased siltation and turbidity due to construction which may effect submerged aquatic vegetation and fish. Adverse effects to the aesthetic conditions of the area.	D.O.P. = 140-year F.C. = $9,454,800 A.A.C. = $731,900 A.A.B. = $137,100 B.C.R. = 0.19
Reduce flood damages in Rock Hall.	Plan RH-2 Map Ref A-G	25,500 feet of levee/wall "ringing" the Rock Hall-Gratitude areas. Includes protection from flooding on Gray's Inn Creek. (12' NGVD design elev.)	Will reduce flood hazard and provide degree of protection indicated for both Rock Hall and Gratitude.	Same as above with additional marsh destruction near Gray's Inn Creek. (< 10 acres)	D.O.P. = stand. project flood F.C. = $13,513,800 A.A.C. = $1,046,300 A.A.B. = $194,500 B.C.R. = 0.19
Reduce flood damages in Rock Hall	Plan RH-3 Map Ref B,C, D	16,000 feet of levee/wall encircling the Gratitude area only. (9' NGVD design elev.)	Will reduce flood hazard and provide degree of protection indicated for the Gratitude area only.	Destruction of marsh areas along the shoreline in Rock Hall Harbor (< 2 acres) northwest of Windmill Point (< 20 acres) two areas near the Havens (< 20 acres) and a fringe area north of Caroline Avenue (< 1 acre). Temporary destruction of benthic organisms due to construction. Recolonization may occur after completion of construction. Some permanent loss of habitat may also occur. Increased siltation and turbidity due to construction which may effect submerged vegetation and fish. Adverse effects to the aesthetic conditions of the area. Use of shoreline will be restricted.	D.O.P. = 140-year F.C. = $7,995,600 A.A.C. = $619,200 A.A.B. = $106,700 B.C.R. = 0.17

TABLE B-1-4 (Cont'd)

COMPARATIVE ASSESSMENT AND EVALUATION
ROCK HALL, MARYLAND

STUDY OBJECTIVE	PLAN	DESCRIPTION OF PLAN	BENEFICIAL EFFECTS	ADVERSE EFFECTS	ECONOMICS
Reduce flood damages in Rock Hall	Plan RH-4 Map Ref B,C, D	16,000 feet of levee/wall encircling the Gratitude area only. (12' NGVD design elev.)	Will reduce flood hazard and provide degree of protection indicated for the Gratitude area only.	Same as above.	D.O.P. = stand. project flood F.C. = $10,308,200 A.A.C. = $798,500 A.A.B. = $139,000 B.C.R. = 0.17
Reduce flood damages in Rock Hall.	Plan RH-5 Map Ref A-B, D-E	9,900 feet of levee/wall encircling the Rock Hall area only. (9' NGVD design elev.)	Will reduce flood hazard and provide degree of protection indicated for the Rock Hall area only.	Partial destruction of marsh areas east of Rock Hall Harbor (< 20 acres) and on the eastern shore of the Havens (< 15 acres). Use of shoreline restricted. Adverse effects to the aesthetic conditions of the area. Temporary destruction of benthic organisms due to construction. Recolonization may occur after completion of construction. Some permanent loss of habitat may also occur. Increased siltation and turbidity due to construction which may effect submerged aquatic vegetation and fish.	D.O.P. = 140-year F.C. = $3,291,600 A.A.C. = $254,600 A.A.B. = $50,400 B.C.R. = 0.20
Reduce flood damages in Rock Hall.	Plan RH-6 Map Ref A-B-D-E-F-G	11,650 feet of levee/wall encircling the Rock Hall area only. Includes protection from flooding on Gray's Inn Creek. (12' NGVD design elevation.)	Will reduce flood hazard and provide degree of protection *indicated for the Rock Hall area* only.	Same as above with the addition of marsh destruction along Gray's Inn Creek. (< 10 acres)	D.O.P. = stand. project flood F.C. = $4,797,000 A.A.C. = $370,900 A.A.B. = $71,500 B.C.R. = 0.19

TABLE B-1-4 (Cont'd)

COMPARATIVE ASSESSMENT AND EVALUATION
ROCK HALL, MARYLAND

STUDY OBJECTIVE	PLAN	DESCRIPTION OF PLAN	BENEFICIAL EFFECTS	ADVERSE EFFECTS	ECONOMICS
Reduce flood damages in Rock Hall.	Plan RH-7	Nonstructural protection to the 5' NGVD (15-year) flood level; includes utility addition, trailer relocation, acquisition and demolition, standard floodproofing, and floodproofing by floodwall.	Will reduce flood hazard and provide degree of protection indicated for entire community.	Loss of unique social life style for those relocated. Construction of floodwall may result in adverse environmental effects such as destruction of adjacent wetland areas, increased siltation and turbidity, and destruction of benthic organisms. Use of shoreline will be restricted. Adverse effects to the aesthetic conditions of the area. Temporary noise pollution.	D.O.P. = 15-year F.C. = $1,093,000 A.A.C. = $80,450 A.A.B. = $22,500 B.C.R. = 0.28
Reduce flood damages in Rock Hall.	Plan RH-8	Nonstructural protection to the 6' NGVD (25-year) flood level; includes utility additions, house raising, trailer relocations, acquisition and demolition, and standard floodproofing.	Will reduce flood hazard and provide degree of protection indicated for entire community.	Same as above.	D.O.P. = 25-year F.C. = $2,504,450 A.A.C. = $184,350 A.A.B. = $50,900 B.C.R. = 0.26
Reduce flood damages in Rock Hall	Plan RH-9	Nonstructural protection to the 7' NGVD (50-year) flood level; includes utility additions, house raising, trailer and house relocation acquisition and demolition, standard floodproofing, and floodproofing by floodwall.	Will reduce flood hazard and provide degree of protection indicated for entire community.	Same as above.	D.O.P. = 50-year F.C. = $4,831,500 A.A.C. = $355,650 A.A.B. = $91,500 B.C.R. = 0.26
Reduce flood damages in Rock Hall	Plan RH-10	Nonstructural protection to the 8' NGVD (80-year) flood level; includes utility additions, house raising, house and trailer relocation, acquisition and demolition, standard floodproofing, and floodproofing by floodwall.	Will reduce flood hazard and provide degree of protection indicated for entire community.	Same as above.	D.O.P. = 80-year F.C. = $7,080,700 A.A.C. = $521,200 A.A.B. = $125,100 B.C.R. = 0.24

TABLE B-1-5

COMPARATIVE ASSESSMENT AND EVALUATION
SNOW HILL, MARYLAND

STUDY OBJECTIVE	PLAN	DESCRIPTION OF PLAN	BENEFICIAL EFFECTS	ADVERSE EFFECTS	ECONOMICS
Reduce flood damages in Snow Hill	Plan SH-1 Map Ref A-C	7,190 feet of levee/wall which runs along the southern banks of the Pocomoke River from north of the Rt. 12 Bridge to the city's southern limits (6' NGVD design elev.).	Will reduce flood hazard and provide degree of protection indicated for the entire community.	Construction will impact on the wooded areas along the river just north of Green Street (< 2 acres). A fringe marsh area along the shore near Commerce Street will be destroyed (< 2 acres). Adverse effects to the aesthetic conditions of the areas especially at Byrd Park. Cypress trees in the park along the shoreline will be impacted due to construction. Temporary destruction of benthic organisms due to construction. Recolonization may occur after completion of construction. Increased siltation and turbidity due to construction which may effect submerge' aquatic vegetation and fish. Use of the shoreline will be severely restricted.	D.O.P. = 70-year F.C. = $3,010,800 A.A.C. = $233,500 A.A.B. = $5,500 B.C.R. = 0.02
Reduce flood damages in Snow Hill.	Plan SH-2 Map Ref A-B	6,080 feet of levee/wall which runs along the southern banks of the Pocomoke River from just north of the Rt. 12 Bridge to the city's southern limits (6' NGVD design elev.).	Will reduce flood hazard and provide degree of protection indicated for the entire community.	Same as above.	D.O.P. = 70-year F.C. = $2,844,600 A.A.C. = $220,700 A.A.B. = $5,300 B.C.R. = 0.02
Reduce flood damages in Snow Hill.	Plan SH-3 Map Ref A-D	7,920 feet of levee/wall which runs along the southern banks of the Pocomoke River from near the northern city limits to the city's southern limits (8' NGVD design elev.).	Will reduce flood hazard and provide degree of protection indicated for the entire community.	Same as above with the addition of extension of impacts on the wooded area near the cemetery (< 10 acres).	D.O.P. = stand. project flood F.C. = $3,741,600 A.A.C. = $290,300 A.A.B. = $9,100 B.C.R. = 0.03

TABLE B-1-5 (Cont'd)

COMPARATIVE ASSESSMENT AND EVALUATION
SNOW HILL, MARYLAND

STUDY OBJECTIVE	PLAN	DESCRIPTION OF PLAN	BENEFICIAL EFFECTS	ADVERSE EFFECTS	ECONOMICS
Reduce flood damages in Snow Hill.	Plan SH-4 Map Ref A-B	6,460 feet of levee/wall which runs along the southern banks of the Pocomoke River from north of the Rt. 12 Bridge to the city's southern limits. (8' NGVD design elev.)	Will reduce flood hazard and provide degree of protection indicated for entire community.	Same as SH-1.	D.O.P. = stand. project flood F.C. = $3,595,600 A.A.C. = $278,900 A.A.B. = $8,800 B.C.R. = 0.03
Reduce flood damages in Snow Hill.	Plan SH-5	Nonstructural protection to the 5' NGVD (25-year) flood level; includes structure raising, acquisition and demolition, standard floodproofing, and floodproofing by floodwall.	Will reduce flood hazard and provide degree of protection indicated for entire community.	Construction of floodwall may result in adverse environmental effects such as destruction of adjacent wetland areas increased siltation and turbidity, and destruction of benthic organisms. Use of the shoreline will be restricted. Adverse effects to the aesthetic conditions of the area. Temporary noise pollution.	D.O.P. = 25-year F.C. = $303,500 A.A.C. = $22,300 A.A.B. = $3,400 B.C.R. = 0.15
Reduce flood damages in Snow Hill.	Plan SH-6	Nonstructural protection to the 6' NGVD (70-year) flood level; includes structure raising, acquisition and demolition, standard floodproofing, and floodproofing by floodwall.	Will reduce flood hazard and provide degree of protection indicated for entire community.	Same as above.	D.O.P. = 70-year F.C. = $521,200 A.A.C. = $38,400 A.A.B. = $6,200 B.C.R. = 0.16
Reduce flood damages in Snow Hill.	Plan SH-7	Nonstructural protection to the 7' NGVD (220-year) flood level; includes structure raising, acquisition and demolition, standard floodproofing, and floodproofing by floodwall.	Will reduce flood hazard and provide degree of protection indicated for entire community.	Same as above.	D.O.P. = 220-year F.C. = $1,210,200 A.A.C. = $89,100 A.A.B. = $8,100 B.C.R. = 0.09

TABLE B-1-6

COMPARATIVE ASSESSMENT AND EVALUATION
ST. MICHAELS MARYLAND

STUDY OBJECTIVE	PLAN	DESCRIPTION OF PLAN	BENEFICIAL EFFECTS	ADVERSE EFFECTS	ECONOMICS
Reduce flood damages in St. Michaels	Plan SM-1 Map Ref A-B, D-C	14,000 feet of levee/wall which begins near Rt. 33 at the town's northern limits, runs around St. Michaels Harbor, and ties into high ground near the southern town limits at Radcliffe Ave. (7' NGVD design elev.)	Will reduce flood hazard and provide degree of protection indicated for area within town's old city limits.	Use of the shoreline will be severely restricted and access to existing piers and wharves difficult. Destruction of fringe marsh areas near Parrot Point and northwest of Navy Point (total area <5 acres). Temporary destruction of benthic organisms due to construction. Recolonization may occur after completion of construction. Some permanent loss of habitat may also occur. Increased siltation and turbidity due to construction which may effect submerged aquatic vegetation and fish. Adverse effects to the aesthetic conditions of the town.	D.O.P. = 100-year F.C. = $7,224,000 A.A.C. = $559,300 A.A.B. = $10,200 B.C.R. = 0.02
Reduce flood damages in St. Michaels	Plan SM-2 Map Ref A-D	23,890 feet of levee/wall which begins near Rt. 33 at the town's northern limits, runs around St. Michaels Harbor to Seymour St., and ties into the levee section near San Domingo Creek at Rt. 33 and the town's southern limits (9' NGVD design elev.).	Will reduce flood hazard and provide degree of protection indicated for area within town's old city limits as well as a portion of the new development near Rio Vista.	Same as above except with the addition of the destruction of a small marsh area at the end of San Domingo Creek (end of Thompson Street). (Total area less than 5 acres).	D.O.P. = 450-year F.C. = $11,970,800 A.A.C. = $926,600 A.A.B. = $16,000 B.C.R. = 0.02

TABLE B-1-6 (Cont'd)

COMPARATIVE ASSESSMENT AND EVALUATION
ST. MICHAELS, MARYLAND

STUDY OBJECTIVE	PLAN	DESCRIPTION OF PLAN	BENEFICIAL EFFECTS	ADVERSE EFFECTS	ECONOMICS
Reduce flood damages in St. Michaels	Plan SM-3	Nonstructural protection to the 6' NGVD (45-year) flood level; includes utility addition, acquisition and demolition, standard floodproofing and floodproofing by floodwall.	Will reduce flood hazard and provide degree of protection indicated for entire community.	Temporary, minor noise pollution and aesthetic disturbances. Construction of floodwall may result in adverse environmental effects such as destruction of adjacent wetland areas, increased siltation and turbidity, and destruction of benthic organisms. Use of shoreline will be restricted. Adverse effects to the aesthetic conditions of the area.	D.O.P. = 45-year F.C. = $730,000 A.A.C. = $53,700 A.A.B. = $8,200 B.C.R. = 0.15
Reduce flood damages in St. Michaels	Plan SM-4	Nonstructural protection to the 7' NGVD (100-year) flood level; includes utility addition, structure raising, acquisition and demolition, standard floodproofing and floodproofing by floodwall.	Will reduce flood hazard and provide degree of protection indicated for entire community.	Same as above.	D.O.P = 100-year F.C. = $916,300 A.A.C. = $67,400 A.A.B. = $10,800 B.C.R. = 0.16

TABLE B-1-7

COMPARATIVE ASSESSMENT AND EVALUATION
TILGHMAN ISLAND, MARYLAND

STUDY OBJECTIVE	PLAN	DESCRIPTION OF PLAN	BENEFICIAL EFFECTS	ADVERSE EFFECTS	ECONOMICS
Reduce flood damages on Tilghman Island	Plan TI-1 Map Ref. Southern Section	17,560 feet of levee/wall encircling the large area south of Knapp's Narrows. (6' NGVD design elev.)	Will reduce flood hazard and provide degree of protection indicated for area south of Knapp's Narrows.	Destruction of fringe marsh areas in scattered patches along the eastern and western shores of Tilghman Island. (Total area < 10 acres). Use of the shoreline will be severely restricted and access to public landings at Knapp's Narrows and Dogwood Harbor will be difficult. Temporary destruction of benthic organisms due to construction. Recolonization may occur after completion of construction. Some permanent loss of habitat may also occur. Increased siltation and turbidity due to construction which may effect submerged aquatic vegetation and fish. Adverse effects to the aesthetic conditions of the town.	D.O.P. = 90-year F.C. = $7,369,800 A.A.C. = $570,900 A.A.B. = $3,300 B.C.R. = 0.00
Reduce flood damages on Tilghman Island	Plan TI-2 Map Ref. Northern Section	5,350 feet of levee/wall encircling the small area north of Knapp's Narrows. (6' NGVD design elev.)	Will reduce flood hazard and provide degree of protection indicated for area north of Knapp's Narrows.	Destruction of marsh area along the cove just north of Knapp's Narrows. (Total area less than 20 acres). Access to shoreline at Knapp's Narrows severely restricted.	D.O.P. = 90-year F.C. = $2,342,400 A.A.C. = $181,600 A.A.B. = $400 B.C.R. = 0.00
Reduce flood damages on Tilghman Island	Plan TI-3 Map Ref. Southern Section	17,560 feet of levee/wall encircling the large area south of Knapp's Narrows. (8' NGVD design elev.)	Will reduce flood hazard and provide degree of protection indicated for area south of Knapp's Narrows.	Same as TI-1.	D.O.P. = stand. project flood F.C. = $8,896,360 A.A.C. = $689,300 A.A.B. = $6,400 B.C.R. = 0.01

TABLE B-1-7 (Cont'd)

COMPARATIVE ASSESSMENT AND EVALUATION
TILGHMAN ISLAND, MARYLAND

STUDY OBJECTIVE	PLAN	DESCRIPTION OF PLAN	BENEFICIAL EFFECTS	ADVERSE EFFECTS	ECONOMICS
Reduce flood damages on Tilghman Island	Plan TI-4 Map Ref. Northern Section	5,350 feet of levee/wall encircling the small area north of Knapp's Narrows (8' NGVD design elev.).	Will reduce flood hazard and provide degree of protection indicated for area north of Knapp's Narrows.	Same as TI-2.	D.O.P. = stand. project flood F.C. = $2,878,200 A.A.C. = $223,200 A.A.B. = $1,100 B.C.R. = 0.00
Reduce flood damages on Tilghman Island	Plan TI-5	Nonstructural protection to 4' NGVD (15-year) flood level; includes trailer relocation, house acquisition and demolition, and floodproofing by floodwall.	Will reduce flood hazard and provide degree of protection indicated for entire community.	Loss of unique social life style for those relocated. Temporary, minor noise pollution and aesthetic disturbances. Construction of floodwall may result in adverse environmental effects such as destruction of adjacent wetland areas, increased siltation and turbidity and destruction of benthic organisims. Use of shoreline will be restricted. Adverse effects to the aesthetic conditions of the area.	D.O.P. = 15-year F.C. = $120,500 A.A.C. = $8,900 A.A.B. = $2,500 B.C.R. = 0.28
Reduce flood damages on Tilghman Island	Plan TI-6	Nonstructural protection to 5' NGVD (40-year) flood level; includes structure raising, home and trailer relocation, acquisition and demolition, standard floodproofing, and floodproofing by floodwall.	Will reduce flood hazard and provide degree of protection indicated for entire community.	Same as above.	D.O.P. = 40-year F.C. = $1,038,150 A.A.C. = $76,400 A.A.B. = $12,500 B.C.R. = 0.16
Reduce flood damages on Tilghman Island	Plan TI-7	Nonstructural protection to 6' NGVD (90-year) flood level; includes structure raising, home and trailer relocation, acquisition and demolition, standard floodproofing, and floodproofing by floodwall.	Will reduce flood hazard and provide degree of protection indicated for entire community.	Same as above.	D.O.P. = 90-year F.C. = $2,772,100 A.A.C. = $204,100 A.A.B. = $21,000 B.C.R. = 0.10

TABLE B-1-8

COMPARATIVE ASSESSMENT AND EVALUATION
CAPE CHARLES, VIRGINIA
(Based on January 1983 prices)

Plan	Description	Beneficial Effects	Adverse Effects	Degree of Protection	First Cost	Average Annual Costs	Average Annual Benefits	B/C Ratio
Structural	Recommend that town consider construction of low dikes, installation of flap gates on storm drains.	Insure that entire town is protected to same tidal elevation as top of existing bulkhead	Minor impact during construction activity	100-year flood*	Cost and benefits of dikes and flapgates not estimated			
Nonstructural								
Plan A	Raise buildings, construct utility additions and temporary closures.	Provide tidal flood protection	"	100-year flood	$502,000	$45,400	$5,000	0.11
Plan B	Raise buildings and construct utility additions.	"	"	100-year flood	458,000	41,500	5,200	0.13
Plan C	Construct utility additions and temporary closures.	"	"	35-year flood **	127,000	11,500	200	0.02
Plan D	Construct utility additions.	"	"	35-year flood	103,000	9,300	300	0.03

*Elevation 8. No wave action, runup, or freeboard considered.

**Elevation 7.

TABLE B-1-9

COMPARATIVE ASSESSMENT AND EVALUATION
FOX HILL AREA OF HAMPTON, VIRGINIA
(Based on January 1983 Prices)

Plan	Description	Beneficial Effects	Adverse Effects	Degree of Protection	First Cost	Average Annual Costs	Average Annual Benefits	B/C Ratio
Structural	6,200 feet of floodwall to protect 50 structures.	provide tidal flood protection	Environmental Impact during construction activity.	100-year	$3,184,000	$352,000	$106,900	0.30
Nonstructural	Raise 59 structures.	"	Minor environmental impact during construction activity. Major social effects during construction activity.	100-year	$2,065,000	$187,000	$108,600	0.58
Nonstructural	Raise 34 structures.	"	"	25-year	$904,000	$81,800	$62,000	0.76

TABLE B-1-10

COMPARATIVE ASSESSMENT AND EVALUATION
POQUOSON, VIRGINIA
(Based on January 1983 Prices)

Plan	Description	Beneficial Effects	Adverse Effects	Degree of Protection	First Cost	Average Annual Costs	Average Annual Benefits	B/C Ratio
POQ-1	Commercial area on Wythe Creek Road near Hudgins Road	Since the average annual damages in this area are less than $1,240 at the 100-year tidal flood stage, further study of this area is not warranted.						
POQ-2	Relocate 96 structures in a trailer court	Provide tidal flood protection	Minor impact during construction activity. Major social effects.	Complete	$ 792,000	$ 71,700	$ 15,000	0.21
POQ-3	Raise 45 buildings	"	"	100-year flood	1,008,000	91,300	39,200	0.43
POQ-3	Raise 9 buildings	"	"	25-year flood	199,000	18,100	21,300	1.18
POQ-4	Raise 383 buildings	"	"	100-year flood	8,754,000	792,800	362,000	0.46
POQ-4	Raise 182 buildings	"	"	25-year flood	3,902,000	353,400	223,800	0.63
POQ-4	Purchase and demolish 58 structures. Raise 124 structures.	"	"	25-year flood	5,127,000	381,200	253,200	0.66
POQ-4	Purchase and demolish 25 structures	"	"	10-year flood	$ 978,000	$ 52,800	$ 27,800	0.53

TABLE B-1-11

COMPARATIVE ASSESSMENT AND EVALUATION
TANGIER ISLAND, VIRGINIA
(Based on January 1983 Prices)

Plan	Description	Beneficial Effects	Adverse Effects	Degree of Protection	First Cost	Average Annual Costs	Average Annual Benefits	B/C Ratio
Structural	Construct concrete walls around ridges	Provide tidal flood protection	Impact on marshland and adjacent areas during and following construction. Also social impacts.	Corps 100-yr	$ 24,891,000	$ 2,503,300	$ 419,000	0.17[1]
Structural	Construct concrete walls around building	Provide tidal flood protection	Impact on marshland and adjacent areas during and following construction. Also social impacts.	Corps stard. Proj. Flood	$ 1,697,000	$ 170,600	--[2]	--[2]
Nonstructural	Raise Buildings	Provide tidal flood protection	Impact on marshland and adjacent areas during and following construction. Also social impacts.	Corps 100-yr VIMS 100-yr	$ 7,781,000 180,000	$ 704,800 16,300	$ 534,100 23,800	0.76[3] 1.46[4]
Nonstructural	Raise Buildings	Provide tidal flood protection	Impact on marshland and adjacent areas during and following construction. Also social impacts.	Corps 25-yr	$ 5,227,000	$ 473,400	$ 370,500	0.78[3]

[1] Affluence factor benefit not projected since b/c ratio is very small.
[2] Not determined. Required for safety of public during severe tidal floods.
[3] Indicates effects of including affluence factor benefit.
[4] Affluence factor benefit not projected since b/c ratio is greater than 1.0.

TABLE B-1-12

COMPARATIVE ASSESSMENT AND EVALUATION
WEST POINT, VIRGINIA
(Based on January 1983 Prices)

Stage Frequency data	Plan Description	Beneficial Effects	Adverse Effects	Degree of Protection	First Cost	Average Annual Costs	Average Annual Benefits	B/C Ratio
Corps	Raise 43 structures	Provide tidal flood protection	Minor environmental and social impact (during construction)	100-year	$ 1,048,000	$ 94,900	$ 40,200	0.42
Corps	Raise 17 structures	Provide tidal flood protection	Minor environmental and social impact (during construction)	25-year	$ 465,000	$ 42,100	$ 38,300	0.91
VIMS	Raise 15 structures	Provide tidal flood protection	Minor environmental and social impact (during construction)	100-year	$ 340,000	$ 30,800	$ 11,200	0.36
VIMS	Raise 3 structures	Provide tidal flood protection	Minor environmental and social impact (during construction)	25-year	$ 90,000	$ 8,200	$ 9,400	1.15

CHESAPEAKE BAY

TIDAL FLOODING STUDY

APPENDIX C

RECREATION AND NATURAL RESOURCES

Department of the Army
Baltimore District, Corps of Engineers
Baltimore, Maryland
September 1984

CHESAPEAKE BAY TIDAL FLOODING STUDY

APPENDIX C - RECREATION AND NATURAL RESOURCES

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RECREATION AND NATURAL RESOURCES

INTRODUCTION

This appendix is intended to provide an overview of the recreational opportunities available in the Chesapeake Bay Region and a description of the natural resources of the area that contribute to, or provide the basis for, the realization of these opportunities. Even though the Chesapeake Bay Tidal Flooding Study concentrated on several communities, it is nonetheless important that the resources of the entire Bay Region be assessed. An understanding of existing opportunities and projected needs in the Bay Region will contribute to an appreciation of the relative contribution made by the communities examined as part of the tidal flooding study. Following this overview of the Bay Region, a discussion is included of the recreational and resource characteristics in each of the Maryland and Virginia communities investigated.

CHESAPEAKE BAY RECREATION RESOURCES

The Chesapeake Bay and its tributaries constitute the largest estuarine system in the United States and one of the largest in the world. The complex functioning of such a system with its myriad of life forms and natural resource characteristics provides for many recreational pursuits. These pursuits encompass a variety of activities including fossil collecting, crabbing, fishing, hunting, hiking, and sailing. The climate of the Bay Region is temperate and continental. It is characterized by abundant precipitation, moderate snowfall, plentiful sunshine and a long frost-free season. Summers tend to be long and humid, while winters are variable. Such a climate is extremely conducive to most outdoor recreation activities.

The Eastern Shore of the Bay, also known as the Delmarva Peninsula, is of low relief and is elaborately dissected by small tributary rivers including the Pocomoke, Wicomico, Nanticoke, Choptank, and Chester. These watersheds are mainly cultivated. Throughout the Bay, the tidal river reaches and baylets are fringed with marshes. Swamp forests are found on sections of the lower Bay. These marshes and swamp forests are ideal hunting areas for deer and waterfowl. The tidal shoreline of the Bay is about 7,325 miles in length of which approximately 60 percent is in Maryland and 40 percent in Virginia. The water surface of the Bay and its tributaries (about 4,400 square miles) provide an enormous area for fishing, sailing, boating, and water skiing.

Early recreational use of the Bay was primarily hunting or fishing. Pleasure sailing craft did not begin to appear on the Bay in significant numbers until the 1870's and 1880's. During the years from 1910 to 1930, the use of power craft began to emerge. Most people, however, did not have the leisure time available to draw upon the Bay as an outdoor recreation resource.

Recreation in the Bay Region during the 1880's and early 1900's was closely linked with tourism and resorts. Because of its rich colonial history coupled with the locational advantages of the national capital, the Bay Region has attracted thousands of tourists every year. The tourist industry continues to be a vital part of the Bay's economy even today.

Following World War II, the increase in population and the development of additional urban areas together with the rise in personal income levels, mobility, and leisure time in such Bay area metropolitan centers as Baltimore, Washington, D.C., Wilmington, Richmond, and Norfolk-Newport News intensified the water-oriented recreational use of the Bay and its tributaries. Along with this general increase in recreation demand on the Bay came a local demand within these metropolitan areas for additional parks and recreation programs.

EXISTING RESOURCE USE

As part of the overall Chesapeake Bay Study, the Bay Region was inventoried for boating, sailing, swimming, camping and picnicking activities. The results of this inventory indicate that the Bay area has facilities for all of these outdoor recreation pursuits. More than 440 boat ramps and 985,000 acres of surface water accommodate sailing and boating interests. More than 2,400 acres of surface water are maintained for recreational swimming. Almost 27,000 picnic tables and 20,000 camp sites are also provided for recreational activity in the Bay area. In addition, an inventory of the eight metropolitan areas in the Bay Region shows a total of about 55,000 acres of parkland. Pressure for expanded recreation in the Bay area is ever increasing. Provision of land and water access for public recreation by the Federal, state, and local authorities has not kept pace with the burgeoning demand. The Heritage Conservation and Recreation Service (HCRS) estimated that the demand for swimming in the study area is four times more than available facilities provide for; that demand for boating facilities is five times the available supply; that camping demand is three times the supply; and that the demand for picnic facilities is about four times the available supply. In the private sector, however, a different response has occurred. Private enterprise has responded to increased demands and controls access to an estimated 47 percent of all land and water recreation acreage in the Bay area. Trailer parks, beaches, resorts, and marinas are the primary types of recreation facilities provided by the private sector.

When recreational resources are inventoried on a regional basis, shortages appear in most areas in terms of outdoor recreational opportunity. Sizable local surpluses occur however, which can be effective in satisfying certain needs on a local level. Various studies have revealed that the most effective way of ensuring recreational opportunity is to plan for it prior to or during an area's development rather than afterwards. Even though problems are evident, the potential for recreation in the Bay area is great. The resources are there, they only need to be developed to allow expanded public use.

Forces are at work at the local, state, and Federal level to maintain existing recreation areas and provide for new facilities and open space. Provisions are often made at the local level by city and county governments and by local school boards. State agencies such as the Commission of Game and Inland Fisheries and the Commission of Outdoor Recreation in Virginia, and the Department of Natural Resources in Maryland provide recreational facilities and plan for new development and land acquisition. The Land and Water Conservation Fund Program, administered by the Heritage Conservation and Recreation Service, and the National Wildlife Refuge Program, administered by the U.S. Fish and Wildlife Service, are also very important in meeting recreation resource needs. Also at the Federal level, plans are being formulated to make available for public use land holdings under the jurisdiction of several agencies.

PROBLEMS AND CONFLICTS

This section considers the problems and conflicts associated with the utilization of the outdoor recreation resources in the Chesapeake Bay area. Among the more significant of these problems are limited access, water pollution, and Bay biota.

LIMITED SHORELINE ACCESS

The 7,325 miles of Chesapeake shoreline offer an opportunity for a variety of uses related to the Bay. Unfortunately, recreation, one of the most obvious and socially desirable uses for the shoreline, is extremely limited at the present time. The Chesapeake Bay is the most inaccessible estuary in the nation, as much of the shoreline is in private ownership. According to a study conducted by the Chesapeake Bay Interagency Planning Committees, only three percent of the Maryland shoreline is publicly owned. In all portions of the Bay, residential development is steadily increasing. Single residence shoreline development has preempted long stretches of waterfront and denied access to the waterfront from adjacent inland areas.

Physiographically, much of the shoreline is not amenable to intensive recreation development because of the extensive amount of swampy wetlands. In fact, much of the land desirable for recreational development is located along the tributaries and embayments and recreation is in high competition with other forms of land development such as second homes, utility development (especially power plants and transmission lines), industry, or military reservations. Furthermore, much of the area adjacent to the sand beaches is the target of not only residential but also industrial development.

In urban areas where recreation opportunities are most sorely needed, the shoreline has often been used as transportation corridors without including provisions for the public use of the shore. A significant percent of the publicly-owned shoreline is held by the Federal government, primarily the military, and is therefore unavailable to the general public. Military ownership has kept large tracts of shoreline from being bought up and developed for purposes other than recreation.

WATER POLLUTION

Recreation beaches have been closed due to water pollution. Water quality has deteriorated in many sections of the tributaries precluding recreation which involves body contact with the water. This finding is especially noteworthy for the urban areas on the Bay where demands are the greatest for water-oriented recreation. For example, the number of bathing beaches in Baltimore County approved for operation by the County Health officials declined from 21 in 1966 to 6 in 1971. Some motor boats and boaters also pollute the waters in or near prime recreation areas. Both Maryland and Virginia have on-going programs relative to this form of pollution.

BAY BIOTA

The stinging sea nettle and the closely related comb jellies or ctenophores, which reach peak abundance in the summer months discourage swimming, water skiing, and fishing. Other deterrents to recreation activities are objectionable growths of aquatic plants such as the Eurasian milfoil and water chestnut which prevent boating and swimming.

FUTURE BAY RECREATION NEEDS

Presented in this section are the findings of a study concerning future outdoor recreation needs in the Chesapeake Bay area. In order to adequately evaluate the ability of the existing recreational facilities supply to meet projected needs, three major elements were considered: future demands for recreation facilities, the anticipated future supply of these facilities, and potential problem areas. Based on an examination of these factors, an estimate of future Bay-wide recreational facility needs was made.

FUTURE DEMAND

Four major types of recreation activity were examined in projecting demands for outdoor recreation facilities in the Chesapeake Bay Region. Boating and sailing, swimming, picnicking, and camping were considered in each of the 12 subregions which comprise the Bay Region. These 12 subregions are illustrated in Figure C-1 and are keyed to the displays in Tables C-1 to C-5. The term "facility requirement" refers to a particular item or outdoor recreation resource able to satisfy the demands of a certain number of people expected to use a facility. For boating and sailing, facility requirements are expressed in both water surface acreage and in ramps and launching lanes so as to present a thorough analysis of activity needs. The acreage requirements shown in Table C-1 reflect a year 2020 need of 105,800 acres. This represents more than three times the acreage devoted to this activity in 1970, with the largest increases expected to occur in the Baltimore, Washington, and Northern Virginia metropolitan areas. Table C-2 shows that the estimated requirements for launching ramps follow the acreage trends: more than three-fold increases with the largest increases expected to occur in the Baltimore, Washington, and Northern Virginia metropolitan areas. The beach acreage requirements associated with the swimming activity are presented in Table C-3. The year 2020 estimated acreage requirements are almost three times the acreage existing in 1970. The largest increases for this activity are also projected to be in the Baltimore, Washington, and Northern Virginia Regions. Estimated picnicking needs in terms of picnic tables are shown in Table C-4 while Table C-5 displays, by region, estimates of campsites required to satisfy the year 2020 activity demands.

CHESAPEAKE BAY STUDY AREA BY REGIONS

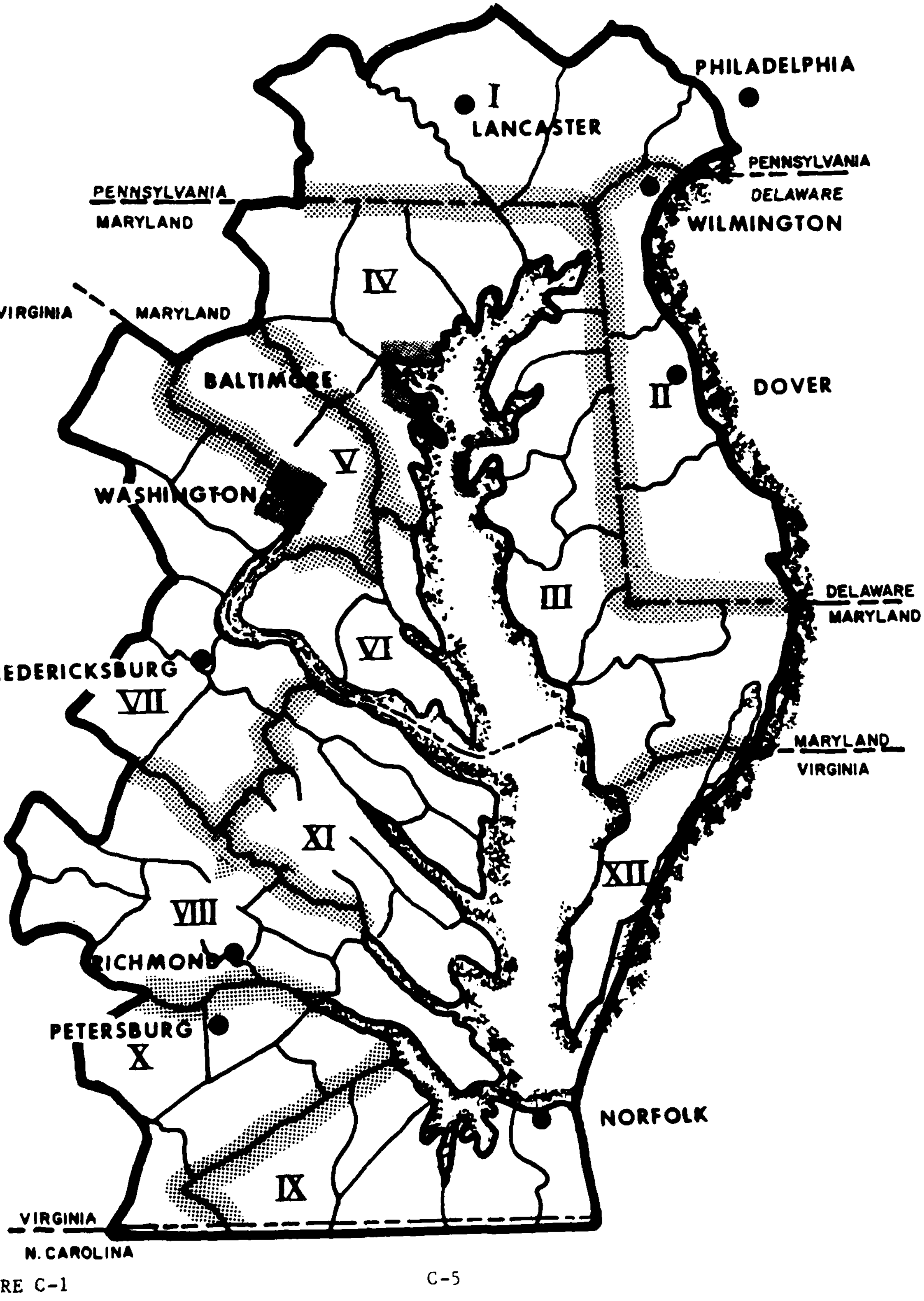

FIGURE C-1

TABLE C-1

BOATING AND SAILING
ACREAGE REQUIREMENTS
IN THE CHESAPEAKE BAY AREA
(Water Surface Acreage)

REGION		YEAR 1970	1980	2000	2020
I	Pennsylvania	3,370	5,020	7,800	13,700
II	Delaware	820	1,110	1,700	3,300
III	Eastern Shore - Maryland	650	930	1,300	2,200
IV	Baltimore	4,880	5,970	9,700	16,500
V	Washington	5,020	6,840	10,200	17,700
VI	Southern Maryland	290	410	700	1,300
VII	Northern Virginia	2,480	4,030	7,400	14,700
VIII	Richmond	1,340	1,940	3,000	5,500
IX	Hampton Roads	2,140	2,750	4,400	5,800
X	Petersburg - Hopewell	400	490	800	1,600
XI	Tidewater	170	230	300	400
XII	Eastern Shore - Virginia	70	90	100	100
*	Total Resident	21,630	29,810	47,400	82,800
**	Total Non-Resident	6,010	8,260	13,100	23,000
	GRAND TOTAL	27,640	38,070	60,500	105,800

*Total resident includes population in the Bay area.

**Total non-resident includes people living outside the Bay area.

TABLE C-2

BOATING AND SAILING
LAUNCHING RAMP REQUIREMENTS
IN THE CHESAPEAKE BAY AREA
(Number of Ramps)

REGION		YEAR 1970	1980	2000	2020
I	Pennsylvania	90	130	210	330
II	Delaware	20	30	40	80
III	Eastern Shore-Maryland	20	20	40	50
IV	Baltimore	130	140	260	400
V	Washington	130	170	270	430
VI	Southern Maryland	10	10	20	30
VII	Northern Virginia	70	100	200	350
VIII	Richmond	40	50	80	130
IX	Hampton Roads	60	70	120	140
X	Petersburg - Hopewell	10	10	20	40
XI	Tidewater	5	10	10	20
XII	Eastern Shore - Virginia	3	3	3	5
*	Total Resident	588	743	1,273	2,005
**	Total Non-Resident	160	210	350	560
	GRAND TOTAL	748	953	1,623	2,565

*Total resident includes population in the Bay area.

**Total non-resident includes people living outside the Bay area.

TABLE C-3

SWIMMING FACILITY REQUIREMENTS IN THE CHESAPEAKE BAY AREA[1]
(Water Surface Acreage)

REGION		YEAR 1970	1980	2000	2020
I	Pennsylvania	50	80	120	170
II	Delaware	10	20	30	40
III	Eastern Shore - Maryland	10	10	20	30
IV	Baltimore	80	100	160	200
V	Washington	80	100	160	200
VI	Southern Maryland	5	10	10	20
VII	Northern Virginia	40	60	120	180
VIII	Richmond	20	30	50	70
IX	Hampton Roads	30	40	60	70
X	Petersburg - Hopewell	10	10	10	20
XI	Tidewater	3	4	5	10
XII	Eastern Shore - Virginia	1	1	2	2
*	Total Resident	339	465	747	1,012
**	Total Non-Resident	100	130	210	280
	GRAND TOTAL	439	595	957	1,292

*Total resident includes population in the Bay area.

**Total non-resident includes people living outside the Bay area.

[1]Beach and Pools.

TABLE C-4

PICNICKING FACILITY REQUIREMENTS
IN THE CHESAPEAKE BAY AREA
(Number of Picnic Tables)

REGION		YEAR 1970	1980	2000	2020
I	Pennsylvania	6,270	7,880	10,600	16,400
II	Delaware	1,500	1,740	2,500	3,700
III	Eastern Shore - Maryland	1,200	1,360	1,800	2,600
IV	Baltimore	9,130	10,010	13,400	18,700
V	Washington	9,250	10,090	13,600	20,200
VI	Southern Maryland	520	590	900	1,400
VII	Northern Virginia	4,670	5,940	9,800	16,800
VIII	Richmond	2,540	2,890	4,100	6,300
IX	Hampton Roads	3,970	4,080	4,900	6,500
X	Petersburg - Hopewell	750	830	1,000	1,900
XI	Tidewater	320	340	400	500
XII	Eastern Shore - Virginia	130	150	160	200
*	Total Resident	40,250	45,900	63,160	95,200
**	Total Non-Resident	11,190	12,760	17,600	26,500
	GRAND TOTAL	51,440	58,660	80,760	121,700

*Total resident includes population in the Bay area.

**Total non-resident includes people living outside the Bay area.

TABLE C-5

CAMPING FACILITY REQUIREMENTS IN THE CHESAPEAKE BAY AREA (Number of Campsites)

REGION		YEAR 1970	1980	2000	2020
I	Pennsylvania	1,100	1,600	2,700	4,200
II	Delaware	280	410	700	1,100
III	Eastern Shore - Maryland	210	290	500	700
IV	Baltimore	1,550	2,130	3,500	5,100
V	Washington	1,480	2,100	3,600	5,400
VI	Southern Maryland	100	140	300	400
VII	Northern Virginia	820	1,240	2,700	4,700
VIII	Richmond	410	640	1,000	1,600
IX	Hampton Roads	690	860	1,300	1,800
X	Petersburg - Hopewell	120	170	250	500
XI	Tidewater	60	80	100	150
XII	Eastern Shore - Virginia	30	30	40	50
*	Total Resident	6,850	9,690	16,690	25,700
**	Total Non-Resident	1,900	2,690	4,600	7,000
	GRAND TOTAL	8,750	12,380	21,290	32,700

*Total resident includes population in the Bay area.

**Total non-resident includes people living outside the Bay area.

FUTURE SUPPLY

The recreation analysis conducted as part of the Chesapeake Bay Study estimated the response of recreation facility supply to projected recreation needs. The basic assumptions and general methodology used in estimating existing facilities supply and in projecting supply responses are presented below.

The recreation facility supply analysis was based on three major assumptions. First, the recreation resource base was assumed to be fixed. It was also assumed for the purposes of the analysis that the supply of outdoor recreation facilities existing at the time of the analysis would represent the recreation facilities supply base. Finally, participation in outdoor recreation activities was assumed to increase. This last assumption was made because of the increased leisure time available to people, a general rise in disposable income, and because of increases in physical mobility.

Since the assumption was made that the resource base was fixed, the existing facilities were assumed to represent the future facility supply. The methodology to define supply consisted of an intensive survey of the Statewide Comprehensive Outdoor Recreation Plans (SCORPs) as well as consultations with and fact gathering from regional planning councils and local officals. The results of this inventory were assessed and are presented in Tables C-6 and C-7.

NEEDS AND PROBLEM AREAS

Based on the facility requirements presented in Tables C-1 through C-5 and the inventory of existing acreage and physical facilities as shown in Table C-6, it was possible to estimate future acreage and facility needs. These estimates of future outdoor recreation needs are presented in Tables C-8 through C-13 for the recreation activities considered. Discussions of each of these recreation activities needs and potential problem areas associated with these needs are presented in the following sections.

Boating and Sailing

The outstanding observation related to boating and sailing in the Chesapeake Bay area is the overwhelming surplus of water surface acreage available to meet projected needs. Even without the inclusion of available inland surface water areas, the vast water surface area of the Chesapeake Bay is more than sufficient to maintain this surplus.

If the Chesapeake Bay is assumed to be the only source of supply to satisfy boating and sailing needs, only 1.8 percent of the Bay's total water surface would have been required to meet 1980 needs of 38,070 acres as shown in Table C-1. By 2020 about 5.1 percent of the Bay's surface water area will fill the projected need of 105,800 surface acres. However, if the inland waterways and the Bay proper were taken together, only 1.2 percent of their combined water surfaces would have been needed to satisfy boating and sailing needs. By 2020 about 3.4 percent of the combined water surface area will be needed. These percentage relationships are presented in Table C-8 while Table C-9 indicates the vast surplus of surface water acreage available.

Boating and sailing are the most visible outdoor recreation activities in the Chesapeake Bay area. The demand, supply and needs methodology indicated that the supply is there;

TABLE C-6

EXISTING SUPPLY OF OUTDOOR RECREATION FACILITIES
FOR THE CHESAPEAKE BAY AREA

REGION		SAILING & BOATING (Acres)	BOAT RAMPS	SWIMMING* (Acres)	PICNICKING (Tables)	CAMPING (Sites)
I	Pennsylvania	26,000[1]	113	22[1]	7,270[1]	1,770[1]
II	Delaware	48,000[2]	20	223[3]	770[3]	610[3]
III	Eastern Shore - Maryland	266,100[2]	91	608[4]	440[4]	1,470[4]
IV	Baltimore	67,300[2]	11	28[4]	4,770[4]	370[4]
V	Washington	14,600[5]	1	12[4]	4,760[6]	560[5]
VI	Southern Maryland	74,800[2]	11	19[4]	1,110[4]	380[4]
VII	Northern Virginia	25,300[2]	14	36[7]	3,360[7]	1,820[7]
VIII	Richmond	40,000[2]	11	9[7]	440[7]	1,210[7]
IX	Hampton Roads	117,600[2]	81	756[7]	2,310[7]	5,390[7]
X	Petersburg - Hopewell	30,100[2]	11	10[7]	250[7]	740[7]
XI	Tidewater	107,300[2]	73	6[7]	430[7]	3,300[7]
XII	Eastern Shore - Virginia	168,300[2]	7	716[7]	730[7]	2,590[7]
TOTAL STUDY AREA		985,400	444	2,445	26,640	20,210

[1] PA Resources Planning
[2] Area measurements U.S. Bureau of Census
[3] BOR Inventory (1971)
[4] Maryland SCORP
[5] National Cap. Region
[6] NAR Study
[7] VA SCORP

* Refer to Table C-7 for a breakdown of acreage into beach and pool acreage.

TABLE C-7

BEACH AND POOL
SURFACE WATER AREA
(Swimming)

REGION		POOL (Square Feet)	POOL (Acres)	BEACH (Acres)
I	Pennsylvania	*	*	22
II	Delaware	*	*	223
III	Eastern Shore - Maryland	1,611,720	37	571
IV	Baltimore	1,045,440	24	4
V	Washington	479,160	11	1
VI	Southern Maryland	43,560	1	18
VII	Northern Maryland	284,719	6.5	30
VIII	Richmond	9,975	0.2	9
IX	Hampton Roads	392,810	9	747
X	Petersburg - Hopewell	16,789	0.39	10
XI	Tidewater	0	0	6
XII	Eastern Shore - Virginia	7,200	0.2	716

* No pool figures given in SCORPs.

NOTE: Conversion factor is 43,560 square feet equals one acre.

TABLE C-8

WATER SURFACE ACREAGE:
NEEDS VERSUS AVAILABILITY

Water Surface Areas	Available Water Surface Acreage	Percent of Surface Acres Required to Meet Resident and Non-Resident Needs			
		1970	1980	2000	2020
Inland Waterways	985,386[1]	1.7	3.8	6.1	10.7
Chesapeake Bay	2,071,680[2]	0.8	1.8	2.9	5.1
Combined Total (Inland Waterway & Bay Proper)	3,056,066	0.5	1.2	1.9	3.4
Total Acres Needed (Table C-1)		27,640	38,070	60,500	105,800

[1]This acreage represents permanent inland water surface of counties in the Chesapeake Bay area, such as lakes, reservoirs, and ponds having 40 acres or more of area; streams, sloughs, estuaries, and canals one-eighth of a statute mile or more in width; deeply indented embayments and sounds and other coastal waters behind or sheltered by headlands or islands separated by less than one nautical mile of water and islands having less than 40 acres. It excludes acres of oceans, bays, sounds, etc., lying within U.S. jurisdiction, but not defined as inland water.

[2]Source: U.S. Bureau of the Census, 1970 Volume I, and Measurements Reports series GE-20 No. 1.

TABLE C-9

CHESAPEAKE BAY AREA
BOATING AND SAILING NEEDS[1]
(Water Surface Acres)

REGION		1970	1980	2000	2020
I	Pennsylvania	22,630 (+)	20,980 (+)	18,200 (+)	12,300 (+)
II	Delaware	47,180 (+)	46,890 (+)	46,300 (+)	44,700 (+)
III	Eastern Shore - Maryland	265,450 (+)	265,170 (+)	264,800 (+)	263,900 (+)
IV	Baltimore	62,420 (+)	61,330 (+)	57,600 (+)	50,800 (+)
V	Washington	9,580 (+)	7,760 (+)	4,400 (+)	3,100 (-)
VI	Southern Maryland	74,510 (+)	74,390 (+)	74,100 (+)	73,500 (+)
VII	Northern Virginia	22,820 (+)	21,270 (+)	17,900 (+)	10,600 (+)
VIII	Richmond	38,660 (+)	38,060 (+)	37,000 (+)	34,500 (+)
IX	Hampton Roads	115,460 (+)	114,850 (+)	113,200 (+)	111,800 (+)
X	Petersburg - Hopewell	29,700 (+)	29,610 (+)	29,300 (+)	28,500 (+)
XI	Tidewater	107,130 (+)	107,070 (+)	107,000 (+)	106,850 (+)
XII	Eastern Shore - Virginia	168,230 (+)	168,210 (+)	168,200 (+)	168,150 (+)
*	Total Resident	963,770 (+)	955,590 (+)	938,000 (+)	902,500 (+)
**	Total Non-Resident	6,010	8,260	13,200	23,000
	GRAND TOTAL	957,760 (+)	947,330 (+)	924,800 (+)	879,500 (+)

[1]Supply limited to inland water only.

*Total resident includes population in the the Study area.

**Total non-resident includes people living outside the Study area.

(+)Indicates Surplus.

however, the Maryland and Virginia SCORP documents assert that boating supply cannot satisfy current needs. The problem therefore, is not the supply of water surface acres but the shortage of marina slips and ramps that provide access to the Bay and its tributaries. This is the problem that should be further analyzed.

Marinas are generally considered to be the responsibility of the private sector because they are profit-oriented. The high cost of renting a marina slip in addition to the cost of the vessel itself precludes those of lower income levels from maintaining either a boating or sailing craft on the Bay. Therefore, rental facilities and public launching ramps with minimal or no charge are required, particularly in the large urban areas of the Bay. Where such facilities do exist, however, there is usually a long waiting period to launch a craft on weekends and holidays.

These manifestations of unmet needs are indicative of the recreational potential of the Chesapeake Bay area for boating and sailing provided ramps, launching lanes, and other access facilities could be made available. The estimated need for an additional 518 ramps to meet 1980 demands, as indicated in Table C-10, could double by the year 2000 and quadruple in 2020. The Baltimore and Washington portions of the Bay are likely to have the biggest shortages of ramp facilities for all projected years. These shortages are expected to range from around 300 in 1980 to 820 in 2020. The only regions of the Bay anticipated to have a surplus of ramps through the year 2020 are the Eastern Shore of Maryland and the Tidewater and Eastern Shore areas of Virginia.

The Boating Almanac 1973, Vol. 4, Chesapeake Bay and North Carolina, recorded over 38,000 slips and moorings in the Chesapeake Bay Study area. According to these listings, approximately one percent were publicly owned slips and moorings. Approximately 125 public launching ramps were also listed. However, when spotted over the miles of shoreline along the Bay, rivers, and Atlantic Ocean, the severe shortage of public launching ramps is readily demonstrated.

These shortages of slips and ramps were also supported based on boating and marina figures available for the State of Maryland. According to the Maryland Department of Economic and Community Development, Division of Tourism, there are over 300 marinas on the Maryland portion of the Bay. The majority are located on the upper portion of the Bay in Anne Arundel, Baltimore, and Cecil Counties. In 1971 Maryland registered more than 66,000 pleasure craft of which approximately 28,000 were trailer boats kept at home. It could be assumed that the remaining 38,000 required marina slips, consequently exhausting the supply of 38,000 slips listed for the Bay area in the Boating Almanac 1973. This does not even consider the needs of Virginia, Delaware, and other states. Furthermore, when the 28,000 trailer boats are viewed in light of the 125 available public ramps in Maryland alone (although some commercial marinas provide ramps), the lack of adequate access to the Bay for boating and sailing becomes apparent.

The above estimates are meant only to show the trend in use of marina slips and launching ramps. Despite the absence of boat registration figures for Delaware and Virginia at the time of data collection, a definite shortage of these facilities is obvious.

The importance of the Chesapeake Bay as a tourist and boating center, and the resultant large influx of non-residents will continue to contribute to the shortage of slips and

TABLE C-10

CHESAPEAKE BAY AREA BOAT RAMP REQUIREMENTS

REGION		1970	1980	2000	2020
I	Pennsylvania	20 (+)	20	90	210
II	Delaware	2	10	20	70
III	Eastern Shore - Maryland	70 (+)	70 (+)	50 (+)	40 (+)
IV	Baltimore	120	130	250	390
V	Washington	130	170	270	430
VI	Southern Maryland	4 (+)	0	10	20
VII	Northern Virginia	50	90	180	340
VIII	Richmond	20	40	70	120
IX	Hampton Roads	20 (+)	10 (+)	40	60
X	Petersburg - Hopewell	1 (+)	2	10	30
XI	Tidewater	70 (+)	70 (+)	60 (+)	60 (+)
XII	Eastern Shore - Virginia	4 (+)	4 (+)	4 (+)	2 (+)
*	Total Resident	133	308	826	1,568
**	Total Non-Resident	160	210	350	560
	GRAND TOTAL	293	518	1,176	2,128

*Total resident includes population in the Bay area.

**Total non-resident includes people living outside the Bay area.

(+)Indicates surplus.

ramps. A more thorough study to obtain accurate slip and ramp figures and to recommend ways to meet boating and sailing facility needs should be conducted.

Swimming

There are two significant aspects of the swimming acreage supply in the Chesapeake Bay areas shown in Table C-11. First, the four regions adjacent to the Atlantic Ocean show extensive surpluses in swimming acreage into the year 2020. Second, the two most highly urbanized regions, Baltimore and Washington, continue to show the greatest need for additional swimming acreage for all projected years.

The four regions with projected surpluses are Delaware, the Maryland Eastern Shore, Hampton Roads, and the Virginia Eastern Shore. With the exception of Northern Delaware and the Norfolk areas, these regions are characterized by low resident population and vast stretches of ocean beach such as Assateague Island National Seashore and Virginia Beach. The swimming surpluses in the above regions indicate that the eastern section of the Chesapeake Bay area is not of high priority in acquisition and development for swimming. However, the large undeveloped areas and frontage on both the Atlantic Ocean and the Chesapeake Bay make them of prime importance because of their great potential for meeting the unfulfilled swimming needs of the whole study area. This is of greater significance if viewed in the light of a potentially large out-of-state visitor rate that could quickly absorb the surpluses.

In contrast to the rural eastern regions of the Bay are the highly urbanized regions of Baltimore and Washington and their growing suburban populations. Both regions have only a few acres of beach although the Baltimore region, with its prime location on the Bay, demonstrates a vast potential for beach swimming if access can be acquired. While showing improvement over the last decade, water quality conditions in the Potomac River still prevent the river from offering little more than short-range potential for swimming supply in the Washington area. Although beach swimming may be highly desirable to urban residents, water pollution and lack of access dictate that swimming needs in these areas will be met to a large degree by swimming pools.

The Pennsylvania and Northern Virginia counties also show substantial need for additional swimming acreage in the years 1980, 2000, and 2020. These two regions are adjacent to the Baltimore and Washington regions respectively, and demonstrate similar urban needs. By 2020 the Baltimore, Washington, Northern Virginia, and Pennsylvania regions combined will need 650 additional swimming acres to satisfy the expected resident demands.

The Federal Water Pollution Control Act Amendments of 1972 could significantly effect the swimming potential of the Bay and its estuaries. This Act emphasized attainment of effluent standards and authorized the Environmental Protection Agency to support state and local pollution abatement programs through financial aid. If the requirements of this act continue to be uniformly executed by the states and municipalities in the Chesapeake Bay area, several new beaches could be opened for public use.

TABLE C-11

CHESAPEAKE BAY AREA SWIMMING NEEDS[1]
(Water Surface Acreage)

REGION		1970	1980	2000	2020
I	Pennsylvania	30	60	100	150
II	Delaware	210 (+)	200 (+)	200 (+)	180 (+)
III	Eastern Shore - Maryland	600 (+)	600 (+)	600 (+)	580 (+)
IV	Baltimore	50	70	130	170
V	Washington	60	80	140	190
VI	Southern Maryland	10 (+)	12 (+)	10 (+)	3 (+)
VII	Northern Virginia	5	20	80	140
VIII	Richmond	10	20	40	60
IX	Hampton Roads	720 (+)	710 (+)	700 (+)	690 (+)
X	Petersburg - Hopewell	4 (+)	2 (+)	2	10
XI	Tidewater	3 (+)	2 (+)	1 (+)	1
XII	Eastern Shore - Virginia	710 (+)	710 (+)	710 (+)	710 (+)
*	Total Resident	2,102 (+)	1,986 (+)	1,729 (+)	1,442 (+)
**	Total Non-Resident	100	130	207	297
	GRAND TOTAL	2,002 (+)	1,856 (+)	1,522 (+)	1,145 (+)

*Total resident includes population in the Bay area.

**Total non-resident includes people living outside the Bay area.

[1] Beach and Pools.

Picnicking

As shown in Table C-12, 9 of the 12 Bay Regions were estimated to fall short of meeting 1980 demands by 20,450 picnic tables. This total shortage could increase to nearly 70,000 tables by 2020. Typically, the greatest projected shortages are in the urbanized regions of Baltimore, Washington, and Northern Virginia which combined account for almost 70 percent of the study area's total resident need for additional picnic tables. By 2020, these three regions will have a sizable need totaling 42,800 tables. This represents 60 percent of the total projected deficit throughout the Bay area. Moderate surpluses are projected for the Southern Maryland and the Virginia Eastern Shore regions. Pennsylvania's estimated 1980 shortage of 610 tables is projected to increase to a deficit of 9,100 tables by 2020.

Picnicking is generally ancillary to other recreation activities and is often found near playing fields, swimming beaches, historic or scenic attractions, camping areas, and major open areas. Resident and non-resident demand however, will differ. Resident picnicking is generally a single day activity and is close to home. Non-resident picnicking will usually be ancillary to such activities as camping, boating or other overnight activities connected with tourism. Unlike boating, camping, and swimming, demand for picnicking has traditionally been met by free or nominal fee facilities. Picnicking is considered a water enhanced activity - an activity which by preference of the participant takes place near water. Visual as well as physical access to the Chesapeake Bay, therefore, would greatly enhance the picnicking experience.

Consequently, any discussion of meeting picnicking demand should include plans to develop such facilities in conjunction with other activities and in existing recreation areas. This is particularly important in the urban areas which show the greatest picnicking shortages and where acquisition of additional acreage for this activity may be feasible. For instance, the Baltimore Urban Recreation Analysis, completed by HCRS in 1974, points out that the Baltimore region needs to acquire about 112,000 additional acres in order to meet the publicly owned recreation and open space land needs of its population. However, much of the existing 60,000 acres still have not been developed and offer an opportunity to meet some of the population's facility needs for activities such as picnicking.

Camping

The most populated regions of the Bay area, Baltimore and Washington, are the only regions to lack an adequate number of sites to meet 1980 residential recreational need for camping. Estimates presented in Table C-13 indicate that these two metropolitan areas needed an additional 3,700 campsites to meet 1980 demands. By 2020 most of the other regions are expected to have unmet needs for camping facilities. The Baltimore and Washington regions together are expected to need 9,500 campsites by 2020 whereas the five other regions with deficits will have a combined need of 6,200 campsites.

The diverse nature of camping and camping facilities should be considered before providing comment on the surpluses and shortages indicated in Table C-13. Camping facility preferences range from transient recreationists looking for motel-like convenience, to destination campers desiring sophisticated facilities, to primitive camping buffs desiring minimum accommodations. Traditionally, sophisticated camping

TABLE C-12

CHESAPEAKE BAY AREA
PICNICKING NEEDS
(Number of Tables)

REGION		1970	1980	2000	2020
I	Pennsylvania	1,000 (+)	610	3,330	9,130
II	Delaware	730	970	1,730	2,930
III	Eastern Shore - Maryland	760	920	1,360	2,160
IV	Baltimore	4,360	5,240	8,600	13,930
V	Washington	4,490	5,330	8,840	15,440
VI	Southern Maryland	590 (+)	520 (+)	210 (+)	290
VII	Northern Virginia	1,310	2,580	6,440	13,440
VIII	Richmond	2,100	2,450	3,660	5,860
IX	Hampton Roads	1,660	1,770	2,590	4,190
X	Petersburg - Hopewell	500	580	750	1,650
XI	Tidewater	110 (+)	90 (+)	30 (+)	70
XII	Eastern Shore - Virginia	600 (+)	580 (+)	570 (+)	560 (+)
*	Total Resident	13,610	19,260	36,490	68,530
**	Total Non-Resident	11,190	12,760	17,560	26,460
	GRAND TOTAL	24,800	32,020	54,050	94,990

*Total resident includes population in the Bay area.

**Total non-resident includes people living outside the Bay area.

TABLE C-13

CHESAPEAKE BAY AREA CAMPING NEEDS
(Camp Sites)

REGION		1970	1980	2000	2020
I	Pennsylvania	670 (+)	170 (+)	930	2,430
II	Delaware	330 (+)	200 (+)	90	490
III	Eastern Shore - Maryland	1,260 (+)	1,180 (+)	990 (+)	790(+)
IV	Baltimore	1,180	2,170	3,130	4,730
V	Washington	920	1,540	3,040	4,840
VI	Southern Maryland	280 (+)	240 (+)	120 (+)	40
VII	Northern Virginia	1,000 (+)	580 (+)	880	2,880
VIII	Richmond	800 (+)	570 (+)	210 (+)	390
IX	Hampton Roads	4,700 (+)	4,530 (+)	4,090 (+)	3,590(+)
X	Petersburg - Hopewell	620 (+)	570 (+)	490 (+)	270(+)
XI	Tidewater	3,240 (+)	3,220 (+)	3,180 (+)	3,150(+)
XII	Eastern Shore - Virginia	2,560 (+)	2,560 (+)	2,550 (+)	2,540(+)
*	Total Resident	13,360 (+)	10,110 (+)	3,560 (+)	5,460
**	Total Non-Resident	1,900	2,690	4,630	7,140
	GRAND TOTAL	11,460 (+)	7,420 (+)	1,070	12,600

*Total resident includes population in the Bay area.

**Total non-resident includes people living outside the Bay area.

units and hook-ups have been provided by the private sector as these types of sites are profit oriented. Primitive, resource oriented camping opportunities generally are provided by the public sector.

The historical nature of the Chesapeake area, its key location on the Atlantic Flyway, and its importance as a recreational boating center all contribute to a large non-resident influx which will demand camping sites in addition to resident demand. Consequently, the surpluses may be absorbed and the shortages of the urban regions increased. Taking into account an energy crisis, two situations may occur in the future: the increased demand for destination-type sites and the increased demand for resource oriented camping. Transient campers may dwindle in number because of the gas shortage and the resultant cost of keeping camping vehicles constantly on the road. The total demand for campsites however, will not decrease but continue to increase. Meeting this demand will require close planning coordination between the public and private sector.

CHESAPEAKE BAY NATURAL AND ENVIRONMENTAL RESOURCES

NATURAL RESOURCES

GEOLOGY

The Chesapeake Bay Region is divided into two geologic provinces - the Atlantic Coastal Plain and the Piedmont Plateau. These provinces run roughly parallel to the Atlantic Ocean in a fashion similar to the Bay itself and join at the Fall Line. This natural line of demarcation generally marks both the limit of tide and the head of practical navigation.

The Atlantic Coastal Plain Province includes the Eastern Shore of Maryland and Virginia, most of Delaware, and a portion of the Western Shore. On the Eastern Shore, and in portions of the Western Shore adjacent to the Bay, the Coastal Plain is largely low, featureless, and frequently marshy, with many islands and shoals sometimes extending far offshore. The Coastal Plain is a gently rolling upland on the Western Shore and in the northern portions of the Eastern Shore. The Coastal Plain reaches its highest elevation in areas along its western edge.

The composition of the Coastal Plain is primarily unconsolidated, southeasterly-dipping sedimentary layers, such as sand, clay, marl, gravel, and diatomaceous earth resting on a base of hard crystalline rock. These layers, which can be readily seen in areas where wells have been drilled, increase in thickness toward the Continental Shelf. In a few isolated areas and in locations where water has cut a deep channel, the basement rock is exposed in ridges.

The Piedmont Plateau is not, as its name implies, a plateau. It is characterized by low hills and ridges which tend to rise above the general lay of the land reaching a maximum height near the Appalachian Province on the west. Many of the stream valleys are quite narrow and steep-sided, having been cut into the hard crystalline rocks which are characteristic of the Province.

The parent material of the Piedmont Plateau is both older and more complicated than that of the Coastal Plain. The structurally complex crystalline rocks have been severely folded and subjected to great heat and pressure thereby creating metamorphic rocks.

SOILS

Soils consist of a thin layer of material made from broken and decomposed rock with added products of decaying organic matter called humus. The Bay area contains soils produced from the three major types of rock, namely igneous, metamorphic, and sedimentary. The first two types are found primarily in the Piedmont Province, whereas the Coastal Plain is composed of sediments.

Climate appears to have a definite effect on soil development. Although the Bay area is generally characterized by a humid climate, local variations in temperature and rainfall produce some differences in soil type. Soil characteristics (texture, drainage, structure, particle size, physical size, physical composition, and degree of development) have had a strong role in determining soil usefulness. Richer, well-drained soils are more productive in terms of agriculture. Few crops can grow on soils which are poorly drained or which lack plant nutrients. Soils on the Coastal Plain are highly variable with regard to drainage characteristics and most soils need lime to neutralize their naturally acidic condition. Piedmont soils are medium-grained, easily filled, and of generally higher fertility than those of the Coastal Plain. A few soils are impermeable when wet, retarding the movement of water and causing waterlogging. As a result, strong surface runoff causes serious erosion of slopes.

CLIMATE

The Bay area is characterized by a generally moderate climate, due in large part to the area's proximity to the Atlantic Ocean. Variations occur however, on a local, short-term basis because of the geographical size of the Bay area.

Precipitation within the Bay Region was studied at selected stations during a 30-year sample record from 1931 to 1960. The average for the study area was 44 inches per year, with geographical variations ranging from about 40 to 46 inches per year. Snowfall, included in the precipitation totals, averaged 13 inches per year and occurred generally between November and March.

Three types of storm activity bring precipitation to the Region. The first type consists of extratropical storms which originate to the west, either in the Rocky Mountains, Pacific Northwest, or the Gulf of Mexico. The second is tropical storm or hurricane activity which originates in the Middle Atlantic or the Caribbean Sea region. The third is thunderstorm activity which is almost always on a local scale. It is this last activity which brings about the greatest amount of local variation in precipitation in the Bay area.

Evapotranspiration, which includes water losses due to evaporation from land and water surfaces and transpiration from plants, amounts to approximately 60 percent of the annual precipitation or about 26 inches per year. Authorities estimate an annual evaporation of 36 to 40 inches from the Bay itself.

The average temperature for the Bay area is approximately 57 degrees Fahrenheit (^{o}F). The Bay is oriented in a north-south direction however, and covers a wide latitudinal area, allowing wide temperature variations. As a result, the temperature at the head of

the Bay averages less than 55°F while at the mouth it averages almost 60°F with some peripheral effect due to the nearness of the Atlantic Ocean.

SURFACE WATER HYDROLOGY

The source of freshwater for the Bay is runoff from a drainage basin covering about 64,160 square miles. Approximately 88 percent of this basin is drained by five major rivers, namely the Susquehanna, Potomac, Rappahannock, York, and James.

These river basins are subject to periodic large climatic extremes, resulting in large fluctuations in flow, such as droughts and floods. Of these, droughts are more geographically widespread and long-term in nature. The Susquehanna, Potomac, Rappahannock, York and James Rivers together produce nearly 90 percent of the Bay's mean annual inflow of approximately 69,800 cubic feet per second.

GROUNDWATER RESOURCES

Large reservoirs of high quality freshwater are located in the groundwater aquifers of the Chesapeake Bay Region. Aquifers are subsurface sand and gravel-type materials with relatively high ability to conduct water. Water levels in the aquifers fluctuate according to the balances between precipitation and aquifer recharge on the one hand, and evapotranspiration, runoff, and withdrawals on the other hand. Of the average precipitation of 44 inches per year, an estimated 9 to 11 inches actually contribute to the recharge of the groundwater reservoirs.

Of the more productive aquifers in the Chesapeake Bay area, the waterbearing formations known as the Columbia Group produce very high yields. Extensive areas on the Eastern Shore and portions of Harford and Baltimore Counties, Maryland, are the principal users of groundwater from these formations. The Piney Point Formation is important in Southern Maryland, portions of Maryland's Eastern Shore, and in areas near the Fall Line in Virginia. Lastly, the Potomac Group provides water to Anne Arundel, Charles, and Prince Georges Counties, Maryland, and is the most important source of groundwater in the Coastal Plain of Virginia.

ENVIRONMENTAL SETTING

CHESAPEAKE BAY ESTUARY

The Chesapeake Bay Estuary is a mere youngster, geologically speaking. It is generally believed that the Bay was formed about 10,000 years ago, at the end of the last Ice Age, when the great glaciers melted and poured uncountable billions of gallons of water back into the world's oceans. As a result of this great influx of water, the ocean level rose several hundred feet and inundated large stretches of the coastal rivers. The ancient Susquehanna, which had drained directly into the Atlantic Ocean near what is now the mouth of the Bay, was one of these "drowned" waterways. Because the area around the old Susquehanna was characterized by relatively low relief, the estuary that was formed covered a large geographical area but was relatively shallow. This newly formed body of water was later to be named "Chesapeake Bay."

Chesapeake Bay varies from 4 to 30 miles in width and is about 200 miles long. Although the Chesapeake is the largest estuary in the United States with a surface area of approximately 4,400 square miles, the average depth of the Bay proper is only about 28 feet and about two-thirds of the Bay is 18 feet deep or less. There are however, deep holes which generally occur as long narrow troughs. These troughs are thought to be the remnants of the ancient Susquehanna River valley. The deepest of these holes is about 174 feet and occurs off Kent Island.

The Chesapeake Bay is a complex, dynamic system. Words like "restless," "unstable," and "unpredictable," which generally describe the young of most animal species, can also be used to describe the young estuary. The ebb and flood of the tides and the incessant action of the waves are the most readily perceptible water movements in the Bay. Average maximum tidal currents range from 0.5 knots to over 2 knots (one knot equals one nautical mile of 6,076 feet per hour). The mean tidal fluctuation in Chesapeake Bay is small, generally between one and two feet. Except during periods of unusually high winds, waves in the Bay are relatively small, generally less than three feet in height.

Within the Bay proper and its major tributaries, there is superimposed on the tidal currents a less obvious, non-tidal, two-layered circulation pattern that provides a net seaward flow of lighter, lower salinity water in the upper layer and a flow up the estuary of heavier, higher salinity waters in the deeper layer. The tidal currents provide some of the energy necessary for the mixing of the two layers.

Tides and wave action (as well as other types of currents) are biologically significant in several ways. They provide mixing, transportation, and distribution of inorganic nutrients. These water movements also affect the dispersion of eggs, larva, spores, gametes, and smaller advanced stages of resident plants and animals; remove waste products and bring food and oxygen to fixed bottom-dwelling organisms; and circulate chemical "clues" which aid predators in locating their prey. Tides and waves are also especially important ecologically to the intertidal zone of an estuary (the shoreline area between high and low tides) because of their wetting action which is beneficial to many plant and animal species. In sheltered waters, the mixing of water by tidal and wave action is important for the prevention of excessively high temperatures and salinity stratification which could be harmful to some biota. The turbulence caused by wave action also plays a role in aeration of the waters to provide sufficient oxygen for biotic respiration.

The mixing of sea water and freshwater in the estuary creates salinity variations within the system. In Chesapeake Bay, salinities range from about 33 parts per thousand at the mouth of the Bay near the ocean to near zero at the north end of the Bay and at the heads of its embayment tributaries. Higher salinities are generally found on the Eastern Shore rather than on comparable areas of the Western Shore due to the greater river inflow on the Western Shore and to the earth's rotation. Salinity patterns also vary seasonally according to the amount of freshwater inflow into the Bay system.

Due to this seasonal variation in salinity and the natural density differences between fresh and saline waters, significant non-tidal circulation often occurs within the Bay's small tributary embayments. In the spring, during the period of high freshwater inflow to the Bay, salinity in the embayments may be greater than in the Bay. Because of this salinity difference, surface water from the Bay flows into the tributaries on the surface

while the heavier, more saline bottom water from the tributaries flows into the Bay along the bottom. As Bay salinity becomes greater through summer and early fall, Bay waters flow into the bottom of the tributaries, while tributary surface waters flow into the Bay.

The natural variations in salinity that occur in the Bay are part of the dynamic nature of the estuary, and the resident species of plants and animals are ordinarily able to adjust to the changes. Sudden changes of long duration or magnitude, may upset the equilibrium between organisms and their environment. Abnormal periods of freshwater inflow (i.e., floods and droughts) may alter salinities sufficiently to cause widespread damage to the ecosystem.

Dissolved oxygen is another important physical parameter. Dissolved oxygen levels vary considerably both seasonally and according to depth. During the winter the Bay is high in dissolved oxygen content since oxygen is more soluble in cold water than in warm. With spring and higher water temperatures, the dissolved oxygen content decreases. While warmer surface waters stay near saturation, in deeper waters the dissolved oxygen content becomes significantly less despite the cooler temperatures because of increasing oxygen demands (by bottom dwelling organisms and decaying organic material) and decreased vertical mixing. Through the summer, the waters below 30 feet become oxygen deficient. By early fall, as the surface waters cool and sink, vertical mixing takes place and the oxygen content at all depths begins to steadily increase until there is an almost uniform distribution of oxygen. While species vary in the level of dissolved oxygen they can withstand before respiration is affected, estuarine species in general can function in waters with dissolved oxygen levels as low as 1.0 to 2.0 mg/liter. However, dissolved oxygen levels of about 5.0 mg/liter are generally considered necessary to maintain a healthy environment over the long term.

The effects of temperature on the estuarine system are also extremely important. Since the waters of Chesapeake Bay are relatively shallow compared to the ocean, they are more affected by atmospheric temperature conditions. Generally speaking, the annual temperature range in Chesapeake Bay is between 32°F and 84°F. Because the mouth of the estuary is close to the sea, it has a relatively stable temperature as compared with the upper reaches. Some heat is required by all organisms for the functioning of bodily processes. These processes are restricted, however, to a particular temperature range. Temperatures above or below the critical range for a particular species can be fatal unless the organism is able to move out of the area. Temperature also causes variations in water density which plays a role in stratification and non-tidal circulation as discussed earlier.

Light is necessary for the survival of plants because of its role in photosynthesis. Turbidity, more than any other physical factor, determines the depth light will penetrate in an estuary. Turbidity is suspended material, mineral and/or organic in origin, which is transported through the estuary by wave action, tides, and currents. While the absence of light may be beneficial to some bottom dwelling organisms since they can come out during daylight hours and feed in relative safety, this condition limits the distribution of plant life because of the restriction of photosynthetic activity. This limiting of plant life (especially plankton in the open estuary) will reduce the benthic (i.e. bottom dwelling) and zooplankton populations which in turn will reduce fish productivity.

Nutrients are the minerals essential to the normal functioning of an organism. In Chesapeake Bay, important nutrients include nitrogen, phosphorus, carbon, iron, manganese, and potassium. It is generally believed that most of the nutrients required by estuarine organisms are present in sufficient quantity in Chesapeake Bay. Excesses of some nutrients are often a more important problem than deficiencies. Excesses of nitrogen and phosphorous for example, may cause an increase in the rate of eutrophication which in turn, can eliminate desirable species, encourage the growth of obnoxious algae, and cause low dissolved oxygen conditions from the decay of dead organisms and other materials. Relatively little is known about the quantities of specific nutrients necessary for the healthy functioning of individual species, or more importantly, of biological communities.

While it is necessary to keep in mind the interactions of these physical and chemical variables when studying Chesapeake Bay, these parameters should not and, in fact, cannot be addressed separately. The Bay ecosystem is characterized by the dynamic interplay between many complex factors. As a simple example, the levels of salinity and temperature will both affect the metabolism of an aquatic organism. In addition, both salinity and temperature can cause a drop in the oygen concentration in the water and thus an increase in the required respiration rate of the organism. While it is true the effects of these variables individually may be of a non-critical nature, the synergistic effects of the three stresses may be severe to the point of causing death. These three parameters in turn, also interact with other physical and chemical variables such as pH, carbon dioxide levels, the availability of nutrients, and numerous others. The subtle variable of time may also become critical in many cases. The important point is that the physical and chemical environment provided by Chesapeake Bay to the indigenous biota is extremely complex and difficult, if not impossible, to completely understand.

BIOTA OF CHESAPEAKE BAY

The estuary is biologically a very special place. It is a very demanding environment because it is constantly changing. The resident plants and animals must be able to adjust to changes in physical and chemical parameters. The requirement for adjustment to the almost constant ecological stress limits the number of species of plants and animals that are able to survive and reproduce in the estuary. Despite the fact that relatively few species inhabit the Bay, the Chesapeake, like most estuaries, is an extremely productive ecosystem.

There are a number of reasons why estuaries are so productive. First, the circulation patterns in the area of mixing of lighter freshwater with heavier sea water in a partially mixed estuary such as the Chesapeake Bay tend to create a "nutrient trap" which acts to retain and recirculate nutrients. Second, water movements in the estuary do a great deal of "work" removing wastes and transporting food and nutrients, enabling many organisms to maintain a productive existence which does not require the expenditure of a great deal of energy for excretion and food gathering. Third, the recycling and retention of nutrients by bottom-dwelling penetrating plant roots, and the constant formation of detrital material in the wetlands create a form of "self-enriching" system. Last, estuaries benefit from a diversity of producer plant types which together provide year-round energy to the system. Chesapeake Bay has all three types of producers that power the ecosystems of our world: macrophytes (marsh and sea grasses), benthic microphytes (algae which live on or near the bottom), and phytoplankton (minute floating plants).

AQUATIC PLANTS

As implied above, certain aquatic plants are critical to the health and productivity of Chesapeake Bay. Green plants use sunlight and the inorganic nutrients in the water to produce the energy to drive the estuarine ecosystem. Thus, these plants, ranging from the microscopic algae to the larger rooted aquatics, are the primary producers - the first link in the aquatic food chain. Aquatic plants exist in the natural environment in a myriad of shapes, forms, and degree of specialization. They are also found in waters of widely varying physical and chemical quality.

Phytoplankton is a general term for aquatic plants of both fresh and saline waters which are characteristically free-floating and microscopic. The most important of the phytoplankton are the green algaes, diatoms, and dinoflagellates. The population of these organisms is represented by relatively few species, but when they do occur, they are present in tremendous numbers. Phytoplankton are the principal photosynthetic producers in marine, estuarine, and freshwater environments, and will grow in the water column to any depth that light will penetrate. Blue-green algae are another type of phytoplankton organism which are not generally considered to be of importance in aquatic productivity, but are best known for the nuisance conditions caused when their growth occurs in excess. Huge populations, or blooms, of these organisms located near the surface of the water reduce the sunlight available to bottom-dwelling organisms. The blooms can also give off objectionable odors, clog industrial and municipal water intakes, and generally cause nuisance conditions.

Macrophytes, as the Greek roots of the word indicate, are large plants. Unlike the freely floating, or only weakly motile minute phytoplankton, the macrophytic aquatic plants are generally either rooted or otherwise fastened in some manner to the bottom. All of the forms require sunlight to conduct photosynthesis and most have defined leaflets which grow either entirely submerged, floating on the surface of the water, or out of the water with leaf surfaces in direct contact with the atmosphere. The distribution of macrophytes ranges from entirely freshwater to the open ocean. These types of plants are not only important as food and habitat for fish and wildlife, but they are also important in the recovery of nutrients from deep sediments.

FISH AND WILDLIFE

The energy supplied to the ecosystem by the green plants of the Bay must be made available in some manner to the meat-eating predators, including man, which are higher in the food chain. This vital link is filled by many different varieties of organisms such as zooplankton and various species of worms, shellfish, crabs, and finfish. Zooplankton include small crustaceans such as copepods, the larva of most of the estuarine fishes and shellfishes, several shrimp-like species, and other animal forms that generally float with the currents and tides. Phytoplankton and plant detritus (along with adsorbed bacteria, fungi, protozoa, and micro-algae) are consumed directly by the zooplankton and other larger aquatic species.

If man through his activity interrupts an established energy flow in the environment, he may cause energy losses to the system as well as other detrimental biological effects. Man's activities, for example, may cause the loss of a detritus producing area (e.g., a stand of saltmarsh cordgrass) resulting in a decline of the organisms which primarily feed

on detritus. A loss of this nature directly affects the next higher trophic level, thereby starting a chain reaction throughout the food web. Generally, in estuaries, there is a great deal of dependence of larger organisms on a few key smaller organisms that utilize detritus and micro-algae for food.

Like the aquatic plant communities, the aquatic animal communities are not spread homogeneously throughout the Bay. Although the entire estuary serves as nursery and primary habitat for finfish, spawning areas are concentrated in the areas of low salinity in the Upper Bay and corresponding portions of the major tributaries. The northern part of Chesapeake Bay, including the Chesapeake and Delaware Canal, is probably the largest of all spawning areas in the Bay. This area plus the upper portions of the Potomac, York, Rappahannock, James, and Patuxent Rivers, represents about 90 percent of the anadromous fish (i.e., those which ascend rivers from the sea to reproduce) spawning grounds in the Chesapeake Bay Region. The Bay serves as a spawning and nursery ground for fish caught from Maine to North Carolina. Some of the fish that use the Bay as a nursery include striped bass, weakfish, shad, alewife, blueback herring, croaker, menhaden, and kingfish.

Oysters are abundant in many parts of the estuary. The numerous small bays, coves, and inlets between the Chester and Nanticoke Rivers along the Eastern Shore and the lower portions of the Patuxent, Potomac, York, Rappahannock, and James Rivers account for approximately 90 percent of the annual harvest of oysters. Some species of Chesapeake Bay fish and shellfish thrive in the saltier waters of the estuary. The mouth of the Chesapeake, an area of high salinity, is the major blue crab spawning area. In addition to Chesapeake Bay's large resources of finfish and shellfish, the marshes and woodlands in the area provide many thousands of acres of natural habitat for a variety of waterfowl, other birds, reptiles, amphibians, and mammals.

Chesapeake Bay is the constricted neck in the gigantic funnel pattern that forms the Atlantic Flyway. Most of the waterfowl reared in the area between the western shore of Hudson Bay and Greenland spend much time in the marshes of the Bay and its tributaries during their migrations. Good wintering areas adjacent to preferred upland feeding grounds attract more than 75 percent of the wintering population of Atlantic Flyway Canada geese. The marshes and grain fields of the Delmarva Peninsula are particularly attractive to Canada geese and grain-feeding swans, mallards, and black ducks. The Susquehanna Flats, located at the head of the Bay, support huge flocks of American widgeon in the early fall, while several species of diving ducks, including canvasback, redhead, ringneck, and scaup, winter throughout Chesapeake Bay. About half of the 80,000 whistling swans in North America winter on the small estuaries in or around the Bay. While the Chesapeake is primarily a wintering ground for birds that nest further north, several species of waterfowl, including the black duck, blue-winged teal, and wood duck, find suitable nesting and brood-raising habitat in the Bay Region.

In addition to waterfowl, many other species of birds are found in the Bay area. Some rely primarily on wetlands for their food and other habitat requirements. These include rails, various sparrows, marsh wrens, red-winged blackbirds, snipe, sandpipers, plovers, marsh hawk, shorteared owl, herons, egrets, gulls, terns, oyster catchers, and curlews. Many of the above species are insectivores, feeding on grasshoppers, caterpillars, beetles, flies, and mosquitoes, while others feed on seeds, frogs, snakes, fish, and shellfish. There are numerous other birds which rely more heavily on the wooded uplands

and agricultural lands for providing their basic habitat and food requirements. Among these species are many game birds, including wild turkey, mourning dove, bobwhite quail, woodcock, and pheasant. It should be emphasized that some of these species require both an upland and a wetland habitat. Modest populations of ospreys and American bald eagles also inhabit the Bay Region.

The Chesapeake Bay Region is also home for most of the common mammals which are native to the coastal Mid-Atlantic Region. The interspersion of forest and farmland and the proximity of shore and wetland areas form the basis for a great variety of ecological systems. The abundance of food such as mast and grain crops and the high quality cover vegetation found on the wooded uplands and agricultural lands support good populations of white-tailed deer, cottontail rabbit, red fox, gray fox, gray squirrel, woodchuck, opossum, and skunk. The various vegetation types found in wetland areas provide indispensible natural habitat requirements for beaver, otter, mink, muskrat, marsh rabbit, and nutria. In addition, there are numerous species of small mammals, reptiles, and amphibians which inhabit the Bay area and are integral parts of both the upland and wetland food cycles.

IMPORTANT PLANT AND ANIMAL ORGANISMS

A survey of prominent Bay area scientists was conducted to determine the most important plant and animal species based on economic, biological, and social criteria. For example, a species would qualify as an "important species" if it were either a commercial species, a species pursued for sport, a prominent species important for energy transfer to organisms higher in the food chain, a mammal or bird protected by Federal law, or if it exerted a deleterious influence on other species important to man. The common names of the 124 species and genera identified according to these criteria are presented in Table C-14.

PLANT AND ANIMAL COMMUNITIES

Although the plants and animals of Chesapeake Bay have been treated separately in the previous discussion, in the real world they are inextricably bound together in communities. Bay communities are important because of the complex interactions between inhabiting organisms, both plant and animal, and between one community and another. In the "eelgrass" community for example, the organic detritus formed by eelgrass, plus the microorganisms adsorbed on it, represent the main energy source for animals living in the community and for animals outside the community to which detritus is transported. In addition, eelgrass performs the following physical and biological functions:

1. It provides a habitat for a wide variety of organisms,

2. It is utilized as a nursery ground by fish,

3. It is a food source for ducks and brant,

TABLE C-14

IMPORTANT CHESAPEAKE BAY PLANT AND ANIMAL ORGANISMS
(common names)

Algae

Blue-green alga
Diatom (4 genera)
Dinoflagellate (3 species)
Sea lettuce
Green alga
Red alga

Vascular Plants (Marsh and aquatic)

Widgeongrass
Saltmarsh Cordgrass
Eelgrass
Horned pondweed
Wild rice
Cattails
Pondweeds
Arrow-arum
Wild celery

Cnidaria

Stinging nettle
Hydroid

Ctenophora (comb jellies)

Comb jelly (2 species)

Platyhelminthes (flatworms)

Flatworm

Annelida (Worms)

Bloodworm
Clam worm
Polychaete worm (4 genera)
Oligochaete worm

Mollusca (Shellfish)

Eelgrass snail
Oyster drill
Marsh periwinkle
Hooked mussel
Ribbed mussel
Oyster
Hard Shell clam

Mollusca (Shellfish)

Coot clam
Brackish water clam
Balthic macoma
Stout razor clam
Razor clam
Soft shell clam
Asiatic clam

Arthropoda (Crabs, shrimp, and other crustaceans)

Barnacle
Copepod (2 genera)
Opossum shrimp
Cumacean
Isopod (2 species)
Amphipod (5 genera)
Sand flea
Grass shrimp
Sand shrimp
Xanthid crab (2 species)
Blue crab

Urochordata

Sea squirt

Pisces (Fish)

Cownose ray
Eel
Shad, herring
Menhaden
Anchovy
Variegated minnow
Catfish, bullheads
Hogchoker
Killfish
Silverside
White perch
Striped bass
Black sea bass
Weakfish
Spot
Blenny
Goby
Harvestfish
Flounder

Pisces (Fish)

Northern puffer
Oyster toadfish

Reptiles

Snapping turtle
Diamond-backed terrapin

Aves (Birds)

Horned grebe
Cattle egret
Great blue heron
Glossy ibis
Whistling swan
Canada goose
Wood duck
Black duck
Canvasback
Lesser scamp
Bufflehead
Osprey
Clapper rail
Virginia rail
American coot
American woodcock
Common snipe
Semipalmated sandpiper
Laughing gull
Herring gull
Great black-backed gull
Forester's tern
Least tern

Mammalia (Mammals)

Beaver
Muskrat
Mink
Otter
Raccoon
White-tailed deer

Endangered Species

Shortnose sturgeon
Atlantic sturgeon
Maryland darter
Southern bald eagle
American peregrine falcon
Ipswich sparrow
Delmarva fox squirrel

SOURCE: Chesapeake Bay Future Conditions Report VOLUME II "BIOTA".

4. The plant physically acts as a stabilizing factor for bottom sediments, which allows greater animal diversity, and

5. It plays a role in reducing turbidity and erosion in coastal bays.

It is evident from the preceding discussion that Chesapeake Bay is an almost incomprehensibly complex physical and biological system. When the human element is added, the complexities and interrelationships become even more involved.

RESOURCES OF FLOOD-PRONE COMMUNITIES

CAMBRIDGE, MARYLAND

Cambridge is located on the Delmarva Peninsula in the central part of Maryland's Eastern Shore where the Choptank River forms the boundary between Dorchester and Talbot Counties. The channel into the Port of Cambridge is approximately one half (0.5) mile west of the U.S. Route 50 Bridge at the confluence of the Choptank River and Cambridge Creek in Dorchester County, Maryland. Cambridge Harbor occupies nearly all of the tidal portion of Cambridge Creek, a tributary on the south of the Choptank River about 18 miles above its mouth.

The County of Dorchester was "summoned" into being by a writ issued by Governor Charles Calvert and his Council on February 4, 1669. Dorchester was named after Sir Edward Sackville, fourth Earl of Dorset, a distinguished statesman serving King James I. In April 1684, an Act of Assembly was passed at "The Ridge" in Anne Arundel County to locate a town on Daniel Jones' plantation on the south side of the Great Choptank River. In 1686 a supplementary act was passed for building a courthouse there and the town was named Cambridge. Construction of this courthouse was at a cost of 26,000 pounds of tobacco - or about $1,300. As early as 1719 Cambridge was used as a shipping port and recognized as the hub of Dorchester County. The town was incorporated in 1793.

Throughout this nation's history, sons and daughters of the City of Cambridge served their country well. The men served with distinction in every armed confict with valour gained, in the Revolutionary and Civil Wars, on both sides of the line. Six governors of the State of Maryland have been Dorchester Countians. Famous daughters include Harriet Tubman, Anna Ella Carroll, and the infamous Patty Cannon.

Several years ago, an inventory was completed of historical structures located within the City. The results of this survey may well lead to the recommendation for establishment of historic districts, since several historically notable structures have been demolished for one purpose or another.

Exploration of the colorful history of the City and County can begin with the Dorchester County Public Library and Dorchester Historical Society (located in the Meredith House on La Grange Avenue, Cambridge). It is sufficient for this very brief historical sketch to note that Cambridge for almost 300 years has performed as the trade, governmental, religious and growth center of Dorchester County.

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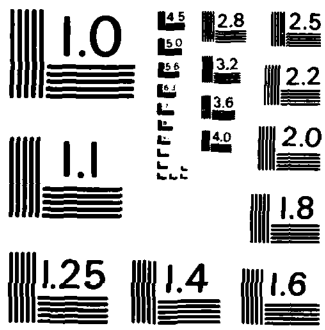

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

EXISTING RECREATION RESOURCES

In many ways the citizens of Cambridge are fortunate in the availability of parks and open spaces. Living within a basically rural county, the countryside is never far, nor difficult to reach, provided that some type of transportation is available. In addition to the pleasant countryside, several large Federal and state facilities are located within easy driving distance of Cambridge. The Blackwater National Wildlife Refuge and Fishing Bay Wildlife Management Area are two of the recreation facilities which offer a variety of opportunities ranging from bird watching to hiking on nature trails. Also easily accessible from the City are many boat launching facilities offering quick access to excellent salt and freshwater fishing, or simply pleasant boat rides.

Within the City, formalized recreation is generally the responsibility of the Dorchester County Recreation and Parks Board. Heavily utilized in the programs of this Board are the existing school sites which are used both for passive and impromptu open space activities, as well as more strenuous recreational activities. In the mid-1970's, the Recreation and Parks Board developed a lighted softball field , Christ Rock, adjacent to the City limits. Projected development includes a large park (100 acres) adjacent to the Snow's Turn Educational Complex, which will offer a variety of open space activities over the next several years. An important asset in serving this park should be the proper development of bike trails on the access roads (such as Route 16 and the proposed Hambrooks Beltway).

When considering the existing open space and parks provided by the Recreation and Parks Board, it should be noted that the School Consolidation Program will abandon many present school sites. While these sites are presently available for citizen usage, they may be lost through the abandonment process. Further, these sites are often located in highly developed residential areas and for these areas could represent the only readily accessible open space.

Cambridge owns outright several open space/park facilities to include Cornish Park (1.4 acres), Great Marsh (18.4 acres) and Long Wharf Park (7.2 acres). While the City may own these areas, formal activities are executed by the County Recreation and Parks Board. Also available in the City is the Franklin Street boat launching ramp, developed in mutual cooperation by the City and County. City expenditures for recreation average about $50,000 annually, mainly for maintenance and salary expenses. The City does contribute several thousand dollars annually to the Recreation and Parks Board.

With the redevelopment of the waterfront on Cambridge Creek by the American Cities/Rouse Corporation, recreational opportunities will be expanded. The proposal for ultimate redevelopment of the area centers around town house construction. Recreational considerations included will be open space, parks, a museum, cultural centers, boat slips, and waterfront upgrading. Additionally, a boat ramp on Great Marsh has been approved for construction as has a pier on Trenton Street which will be owned by the City. When completed these facilities will further expand the recreational opportunities available to the Cambridge area.

FUTURE RECREATION CONSIDERATIONS

The following paragraphs were taken from the Cambridge Comprehensive Plan prepared in 1978 and represent the recommendations/considerations of the community relative to future recreation development.

There is an accepted planning designation which can be used to determine if a community has adequately sized facilities to serve its citizens. Using these criteria, Cambridge should have about 120 acres (10 acres per 1,000 people) of parks/open space ranging in function from play lot, neighborhood parks, and town parks, to general community parks. Similar to many other minimum criteria, these standards simply direct community thought to how its recreation needs are being met, as viewed in relation to minimum standards.

In applying these standards to Cambridge, certain strengths and weaknesses become apparent. By including all available land (as well as land which will become available) the City apparently has adequate acreage for parks and open spaces. Realizing that all of these sites may not continue to be available (school consolidation) or may not be easily accessible without transportation, changes this perspective. Further, the function of each park is open for review since some sites offer open space without the opportunity for some formalized recreational activities. It is particularly important that the function of the parks and open space meet the recreational needs of the total Cambridge population by providing opportunities for all age groups.

Certain directions become evident when reviewing the City's present availability of parks and open spaces. Cambridge must retain or make available open spaces in high density residential areas. Historically, these have been associated with the school system and parcel sizes reflect considerable variation. Most have been, or will be, lost through the School Consolidation Program. Further, functional opportunities in parks/open space must, where possible, consider the needs of all age groups. Availability, but under-utilization of existing land also is evident by Great Marsh, a priceless asset which few cities can match. Utilizing all available funds, Great Marsh could be retained and lightly developed at the minimum as a City-wide oriented park. Over the years several attempts have been made to begin recreational development of Great Marsh. As mentioned previously, a boat ramp is to be constructed on Great Marsh; this will open the area for some water-oriented recreation. Most attempts have been overly ambitious, with the land continuing to remain recreationally under-utilized. The unique water orientation of Great Marsh and its potential to serve as a most pleasant open space area demands that the careful utilization of this land receive the highest priority. Since the service potential of some City parks/open spaces may extend beyond the City limits, development may be undertaken by mutual cooperation between Cambridge and Dorchester County. Proper utilization of available open land is particularly important to Cambridge, since its financial position makes it difficult for the City to expend large sums of money to acquire additional open space.

As a manifestation of the recreational needs of its citizens, the City could also cooperate closely with the County Recreation and Parks Board. This Board has primary recreational responsibility, but the City should be concerned with citizen needs and whether these needs are being met. Further, cooperative efforts could result in City ownership, with the Board providing the recreational equipment and programs.

Annexation has provided the City with the opportunity of planning parks and open spaces in relation to future development. It is an accepted procedure that communities require open space and parks to be part of a subdivision. This process could at least provide the land for neighborhood parks. Land for larger parks is also more readily available in the annexation area, since most of the land is undeveloped and represents lower land costs. Many communities have used a combination process—developers with additional community land purchase—to provide for larger park needs. In the Cambridge Creek waterfront area, open space is being planned for in conjunction with the town house development.

When considering parks and open space, consideration must be given to accessibility and transportation. Neighborhood parks are generally within walking distance, but larger facilities require traffic and parking considerations. Bike paths are becoming popular as one form of active recreation used by all age groups to reach the larger park facility.

ENVIRONMENTAL RESOURCES

Water Quality

Water quality in the Cambridge Harbor area of the Choptank River does not meet the bacteriological standards of the Maryland Department of Health and Mental Hygiene for Class II waters. Water quality standards for Class II (shellfish harvesting) waters are as follows: Bacteriological—coliform density must be less than or equal to 70 MPN per 100 milliliters of sample (MPN is most probable number of colonies). The waters must comply with sanitary and bacteriological standards as listed in the latest edition of Manual of Recommended Practices for Sanitary Control of the Shellfish Industry. The dissolved oxygen concentration must be greater than or equal to 4.0 milligrams per liter (mg/l) at all times, with a minimum monthly average greater than or equal to 5.0 mg/l, except where lower values occur naturally. The pH must be greater than or equal to 6.5 and less than or equal to 8.5, except where pH outside this range occurs naturally. The temperature elevation must not exceed 5°F above the natural temperature, with a maximum temperature of 90°F. Turbidity levels may not exceed levels detrimental to aquatic life for extended periods of time. Turbidity of discharged water may not exceed 50 Jackson Turbidity Units (JTU) as a monthly average, nor exceed 150 JTU at any time. The Cambridge Harbor area, including Cambridge Creek, has been closed to shellfish harvesting since 1963 due to high concentrations of fecal and total coliform bacteria. A large portion of the ambient coliform concentration is caused either by the lack of proper sewage treatment or improper sewage treatment and storm water runoff from upriver sources. Until June 1974 the City of Cambridge (the largest sewage treatment facility on the river) discharged approximately 3.8 million gallons of primary treated sewage into the river daily. Both total and fecal coliform concentrations decrease from the headwaters of Cambridge Creek into the middle portions of the Choptank River. Since the new treatment plant is completed it is anticipated that the coliform concentrations will decrease and the water quality will improve.

National Pollutant Discharge Elimination System (NPDES) Permits granted by the Environmental Protection Agency have been issued for discharging into the Choptank River in the Cambridge vicinity. These permits, granted to industries, local agencies, and the hospital, allow the discharge of pollutants that meet applicable requirements or provisions.

Although a large number of industries discharge their effluent into the river, the concentration of heavy metals as determined by the Maryland Department of Natural Resources and the National Marine Fisheries Service (1971) did not indicate a heavy metal problem in the river. In fact, their findings indicated that in general the waters of the Choptank River were relatively free from contamination by heavy metals. Water quality information accumulated by the Environmental Protection Agency for the Cambridge Creek tributary of the Choptank River (from 1946 through 1971) revealed only traces of heavy metals in the water. Due to the insufficient and infrequent number of samples and the methods of analysis, the interpretation of this information to realistically reflect the present conditions was unachievable.

Since traces of heavy metals were indicated to be present by prior studies and it is known that heavy metals readily accumulate in silty bottom sediments, three bottom samples were collected and analyzed. The results of these analyses indicated that the presence of heavy metals in the sediments of the approach channel and turning basin did not occur in unusual or excessive concentrations. When compared to the average and range of heavy metals contained in the sediments of the Chesapeake Bay, the sediments of the Cambridge Harbor are at the lower levels of the range. It should be noted that the concentration of mercury, which in recent times has been of major concern in the contamination of seafood, is far below the Great Lakes Criteria. Although the concentration of zinc (61, 59, and 58 mg/l for samples one through three respectively) marginally exceeds the Great Lakes Criteria of 50 mg/l, the concentration of zinc for the harbor area is at the lower range for zinc occurring in the sediments of the Bay.

Biota

The Choptank River from Cambridge downriver supports a viable oyster fishery during the fall and winter, and a blue crab fishery during the summer and early fall. Within the general vicinity of Cambridge the river contains approximately 1,474 acres of charted oyster bars. However, since 21 October 1973, these bars and those upriver from the southwest bank of Porpoise Cove on the Talbot County side to DuPont Estate on the Dorchester County side, have been closed to oyster and clam harvest by the Maryland Department of Health and Mental Hygiene due to high coliform bacteria concentrations. Prior to the closure of these bars both clams and oysters had been significantly abundant to support a commercial fishery. The soft-shell clam fishery was decimated by the freshwater intrusion caused by Tropical Storm Agnes in June 1972. Blue crabs constitute the most important shellfishery in the area. Both commercial and sport crabbers harvest large numbers of blue crabs annually.

Invertebrates and Finfish

Typical invertebrates common to the lower Choptank River and often associated with oysters and soft clams are shown in Table C-15. Table C-16 lists the natural oyster bars in the vicinity of the Port of Cambridge and the Choptank River. Due to its diversity of habitats, the Choptank River supports a wide variety of fish life. The river annually supports large anadromous migrations of blueback herring, alewife, striped bass, white perch, gizzard and American shad. Although the ultimate destination of these migratory species is considerably upriver, these species feed and school in the area near Cambridge during upstream and downstream movement. Non-anadromous species utilizing the harbor area and lower river portions as a nursery ground include spot, white flounder,

TABLE C-15

INVERTEBRATES COMMON TO THE LOWER CHOPTANK RIVER

ANNELIDA	CRUSTACEA	MULLUSCA
Glycera dibranchiata	Callinectes sapidus	Nassarius vibex
Pectinaria gouldi	Rhithropanopeus harrisii	Brachiodontes recurvus
Amphitrite ornata	Palaemonetes sp.	Modiolus demissus
Nereis succinea	Crangon septemspinosa	Crassostrea virginica
	Cyathura polita	Macoma balthica
		Macoma phenax
		Mya arenaria
		Tagelus plebius
		Mulinea lateralis

NOTE: These typical invertebrates are often associated with oysters and soft clams.
SOURCE: National Marine Fisheries Service

TABLE C-16

NATURAL OYSTER BARS NEAR CAMBRIDGE

OYSTER BAR	ACRES
DORCHESTER COUNTY	
Shoal Creek	135
Green Marsh	218
Green Marsh Addition #1	34
Green Marsh Addition #2	104
Hambrooks	140
Total	631
TALBOT COUNTY	
Bolingbroke Sand	106
Scraping Line	82
Scraping Line Addition	292
Kirby Addition #1	148
Kirby	215
Total	843
GRAND TOTAL	1,474

NOTE: These oyster bars are in the vicinity of the Port of Cambridge and the Choptank River.
SOURCE: Information furnished by the National Marine Fisheries Service based on charted oyster bars.

yellow perch, bluefish, Atlantic croaker, and weakfish. Trawl and seining data collected during the summer and fall months of 1973 by the Maryland Department of Natural Resources in Cambridge Harbor and the turning basin reveal the dominant species to be spot, white perch and bay anchovy.

The fisheries resource of the Choptank River makes this tributary an important area for commercial and sport fishing. Important commercial species include white perch, striped bass, alewife and catfish. Reported commercial fish harvests on the Choptank River from 1969 through 1973 totaled 3.13 million pounds. A small intensive recreational sport fishery is centered in the Cambridge area. Under normal conditions, anglers may be seen fishing daily from the U.S. Route 50 Bridge crossing the Choptank River or from small boats near the bridge.

Waterfowl

The Choptank River provides one of the more important waterfowl areas in the Upper Chesapeake Region. According to Stewart's 1955 and 1958 waterfowl studies, waterfowl use is the heaviest during mid-winter (early December through mid-January) although large populations are also prevalent in late and early spring. Canada goose, black, redhead, and canvasback ducks are dominant in the fall, winter, and spring. American widgeons are most abundant during the fall, and scaups most abundant during the spring. Whistling swans are usually present in large numbers throughout the migratory season. Waterfowl information furnished by the Maryland Wildlife Administration indicates that the average migratory waterfowl use of the Upper Choptank River during the annual January surveys has increased. However, according to the five year average of mid-winter waterfowl surveys conducted by the State and the U.S. Fish and Wildlife Service for the 1964-1968 and 1969-1973 periods, waterfowl populations have remained about the same.

Although the Choptank River has considerable waterfowl use it should be noted that the largest concentrations of migratory waterfowl are located in wetlands and farmlands adjacent to the river. Waterfowl use in this area has been greatly reduced due to human activity and boating.

Rare and Endangered Species

Although no known endangered species are indigenous to the area, several species have been known to occur near Cambridge. These species include the southern bald eagle (*Haliaeetus l. leucocephalus*), arctic peregrine falcon (*Falco peregrinus tundrius*), Delmarva Peninsula Bryant fox squirrel (*Scurus niger cinereus*) and the shortnose sturgeon (*Acipenser brevirostrum*). Although the southern bald eagle has been observed in many areas on the eastern shore of Maryland, no active or inactive nestings have been reported in the Cambridge vicinity in recent years. In a 1962 bald eagle census of Chesapeake Bay (Larson and Abbott, 1962), bald eagles were noted on the Dorchester and Talbot County side of the Choptank River. The arctic peregrine falcon could possibly occur near the Cambridge area during migration from their feeding grounds in Greenland to the Gulf Coast and Central and South America. However, the occurrence and utilization of the area by this species is probably unlikely, due to man's activity.

The only endangered mammal which is likely to occur in the immediate area is the Delmarva Peninsula Bryant fox squirrel, which is found in some wooded areas of both Dorchester and Talbot Counties, as well as other eastern shore counties. The Delmarva Peninsula Bryant fox squirrel is reported to be most abundant in Talbot and Dorchester Counties and to be confined to stands of heavy mixed timber found along tidal marshes and rivers (Flyger, 1964). Dozier and Hall (1944) reported that this species favors old growth loblolly pine forests.

The shortnose sturgeon may occur in the Choptank River. However, no recent records are available to substantiate its existence.

Osprey (Pandion haliaetus carolinensis), although not included in the threatened wildlife list, have been declining in recent years on a nationwide basis. Osprey inhabit wetlands along the Choptank River and the eastern shore of Maryland (Reese, 1972). The estimated breeding population of osprey on Maryland's eastern shore was 741 pairs in 1973 or 33 percent of the breeding population in Chesapeake Bay. This incidentally represents the major North American, or possibly world, population of ospreys (Henny, Smith and Stotts, 1974).

Wetland Types

Coastal salt marsh and irregularly flooded salt marsh wetland types occur in the immediate Cambridge area. A total of approximately 40 acres of irregularly flooded salt marsh can be found near Jenkins Creek, Hambrooks Bar, Gray Marsh Point and at a site near the Cambridge residential and industrial center. All of these lands are privately owned and most support hunting, fishing, and crabbing activities. Some of the dominant vegetative species are Spartina alterniflora, Baccharis halimifolia, Myrica cerifera and Ruppia maritima.

The Shoal Creek area has approximately 40 acres of coastal salt marsh wetlands. This area is partially owned by the State Hospital while the rest is under private ownership. These wetlands provide excellent opportunities for duck and upland game hunting activities. The dominant vegetative species are Spartina spp., Myrica cerifera, Baccharis halimifolia, and Juncus roemerianus.

CRISFIELD, MARYLAND

Crisfield, the southernmost city in Maryland, is located at the terminus of Maryland Route 413. The City is approximately 14 miles south of U.S. Route 13, the major north-south highway on the Delmarva Peninsula. The community is situated on the Little Annemessex River, just off Tangier Sound, at the lower end of Maryland's portion of Chesapeake Bay. Although "off the beaten path," Crisfield is only approximately 30 miles from Salisbury, the economic and cultural center of the lower Delmarva Peninsula. More significant though, is the fact that Crisfield is strategically located in the southern portion of the Chesapeake Bay, approximately three miles from deep water (depths greater than 35 feet). The City is connected to the deep water by a channel which is permanently maintained to depths of eight to ten feet.

Crisfield's waterfront location has provided its major "raison d'etre" for over 100 years, since the first oyster house was built in 1865. The community at that time was known as

Somers Cove, but was renamed after the president of the Eastern Shore Railroad Company who "fell in the water" upon a visit to the area. The Eastern Shore rail line had been extended to the community in 1866 for the transporting of oysters and it played a signficant role in the City's future.

Crisfield was incorporated in 1872 and grew steadily for the next fifty years. The economic prosperity of the community was based largely upon the seafood and shipping industries, boosted by the excellent combination of waterfront location and rail transportation. Not only did local waters supply a growing seafood business, but Crisfield became "the seafood capital of the world" as the seafood harvest was brought by boat to the town from other areas and then distributed by rail. It is said that during the 1920's as many as 60 railroad cars per day left Crisfield loaded with seafood.

After reaching a peak of 4,100 persons in 1920, Crisfield's population slowly declined to its current level of around 3,000. A major reason for the decline has been a loss of jobs due largely to the dispersal of seafood activities to other areas.

Somerset County is essentially a rural, agricultural area with large tracts of undeveloped land and several hundred miles of shoreline. The county contains some 40,000 acres of wetlands and 85,500 acres of forests, which together comprise nearly 60 percent of Somerset County's land area. Consequently, there are many "undeveloped" or "natural" areas that have value as scenic attractions for tourism as well as significant ecological productivity. The basis for the tourism industry in Somerset County is its natural resources: hunting, camping, fishing, crabbing, and recreational boating; and the historic features of the area.

Ambient noise levels in the county and city are relatively low, as could be expected. The lack of topographic relief supports the propagation of existing noise levels over considerable distances. The overall aesthetic picture of Somerset County and Crisfield is rather mixed: a combination of natural, undeveloped "wilderness" areas, and the decay characteristic of rural, semi-developed areas segregated from the mainstream of national economic growth by their remoteness.

EXISTING RECREATION RESOURCES

Somerset County's 619 miles of shoreline offer excellent opportunity for water-oriented recreation. Public boat launching ramps provide access to most of the County's major waterways. Somers Cove Marina in Crisfield is considered one of the finest on the East Coast, offering one hundred and forty-four slips, a launching ramp, and complete boating services.

Tangier Sound and its tributaries are noted for excellent fishing throughout the spring, summer, and fall. Charter fishing boats are available for hire in the tidewater communities of Deal Island and Crisfield.

Somerset County offers an excellent opportunity for hunters. Waterfowl live in, or near, almost every creek and river in the County. Rabbits, squirrels, raccoon, and deer are plentiful. Many sportsmen own private lodges throughout the County. There are four Federal Wildlife Management areas in the region.

The Somerset County Recreation Commission employs a full time director to organize many recreational activities for youths and adults. A number of community councils cooperate with the Commission in determining programs. Services provided by the Commission include: school facilities for youth programs, training programs for volunteer and part-time leaders, and construction of recreational facilities such as athletic fields and tennis courts.

Janes Island State Park, located at the mouth of the Crisfield Harbor, is composed of almost 3,000 acres of shoreline property. A developed portion of the park on the mainland offers camping facilities and a boat ramp for small boats. Swimming is not allowed in this area. The island portion of the park can be reached only by boat. Swimming is permitted at the beaches on the island, and the waters around the island offer a good yield for the crabber or fisherman. Boaters may enjoy exploring the endless inlets and marshlands, canals, and inland ponds which make up a large part of the island.

Smith and Tangier Islands can be reached during the summer months by excursion boats leaving from Crisfield. Smith Island is in Maryland and Tangier Island is in Virginia. The islands were first discovered in 1608 by Captain John Smith while searching for a salt supply for the Jamestown settlement.

The Crisfield Hard Crab Derby has been an annual Labor Day weekend event since 1947. In recent years, the event has grown to include over one hundred entrees representing California, Hawaii, Alaska, and many other states. Street parades, boat parades, a beauty contest, fireworks, and other activities complement the crab race during Derby weekend.

FUTURE RECREATION CONSIDERATIONS

Although provision of parks and recreational facilities is under the jurisdiction of the County, according to the Comprehensive Plan for Crisfield its citizens feel that there should be a City-wide program to establish neighborhood and community parks. The recommendations of local interests are presented in the following paragraphs.

Development of neighborhood parks at the two elementary school sites has been proposed. Such neighborhood parks should contain playground facilities as a minimum but passive areas and pavilions for picnicking, arts and crafts, and similar activities should also be planned. Additional neighborhood park development is recommended in the central area of the City, the specific location to be determined through further study by the Planning Commission. Two community parks are recommended: one in the northern portion of the City, in the vicinity of Lorie C. Quinn, Sr. Drive; and the other in the southern portion of the City, next to the Woodson Middle School. Such community parks should contain picnic areas, active recreational facilities such as tennis and handball, and passive areas for walking, sitting, and quiet enjoyment. In general, recreational activities which require major athletic facilities such as baseball and softball, football and soccer, and track should be provided at the Middle School and High School.

Additional park and recreational needs include further development of boat launching ramps, particularly in conjunction with the Somers Cove Marina expansion, development of the public beach at the American Legion site, and development of a downtown public park for passive pedestrian enjoyment.

ENVIRONMENTAL RESOURCES

Water Quality

The Tangier Sound area encompasses the Little Annemessex River, Deal Island, and the water area between Smith, South Marsh, and Bloodsworth Island, and the mainland (Somerset County). Besides the mixing and exchange that occurs with the Chesapeake Bay, the Tangier Sound segment has the Nanticoke, Wicomico, and Big Annemessex Rivers emptying into it.

All waters within this segment are Class II (shellfish harvesting) except Jenkins Creek which is Class I. As of August 1976, parts of the Little Annemessex River have been reopened to shellfish harvesting. All other Class II waters remained open.

The major center of pollution in this segment is Crisfield which is located on the Little Annemessex River. Crisfield has a secondary treatment sewage treatment plant which discharges effluent into the river. Additional pollutant contributions can be attributed to boating activites, shoreline erosion, failing rural septic systems and agricultural runoff. The remaining areas of this segment are chiefly wetlands and any resulting pollutant contributions are from nonpoint sources.

One trend station located in Crisfield was sampled six times between April and October, 1976 and all parameters for Class II waters (except one bacterial sample) were met. An intensive survey of the Little Annemessex River and its tributaries was conducted during July 1976, for the purpose of information input for modeling. All standards for Class II and Class I waters were met. From this limited amount of information, water quality appears to be good in this area. One biological station was also sampled at Crisfield. The species diversity index was 2.90 (3.0 is a minimum for clean water designation) indicating good water quality.

The Big Annemessex River segment encompasses a drainage area of forty-seven square miles with few large population concentrations. The segment includes the Crisfield Airport and several waste treatment facilities. There were no EHA Class II (shellfish harvesting) closures in this segment during 1976. One intensive survey was conducted mainly for input information for modeling and included the mainstem and tributaries. Class II waters are designated from River Road to the mouth with the remainder being Class I. All standards were met for pH and temperature within this segment. Low chlorophyll "a" levels were observed. Dissolved oxygen standards were also met except for one low value (3.6 mg/l) near the headwaters of Hall Creek. Fecal coliform numbers exceeded maximum acceptable levels for Class I waters in the headwaters of Hall Creek, the headwaters of Big Annemessex River, and on Annemessex Creek. Several stations in shellfish harvesting waters (Flatland Cove, mouth of Gales Creek, midchannel near Moon Bay) slightly exceeded maximum values.

Biota

Crisfield and the surrounding area abounds in fish and wildlife. The most significant wildlife habitat is the wetlands which comprise 13 percent of the City. Most occur in the Jersey section of the City. This land supports a variety of wildlife including waterfowl, rodents, deer, fox, and other species. Vegetation consists primarily of grasses and

typical marsh plants with few areas being wooded. The grassy, wet areas are important for the nurturance of fingerling fish and shellfish.

The adjacent Janes Island State Park comprises 3,000 acres and supports a variety of vegetation and wildlife typical of Chesapeake Bay salt water marsh land. The adjacent Little Annemessex River and Tangier Sound are valuable for their fishing (drum, trout, spot) and crab populations. Nearby waters also abound in oysters and clams.

Major environmental problems for Crisfield concern the protection of wetlands, surface drainage and unstable soils. Approximately 15 percent of the community's land area is unsuitable for development in its present state. Another potential problem for the community is the protection of water quality, especially since the valuable shellfish grounds in the area are such an important part of the economy. This problem is compounded by the fact that the soils of the area have poor percolation and areas outside the City are not served by the central sewer system.

Invertebrates

Table C-17 lists the predominant invertebrates found in the waters in and around Somerset County. Important fin and shellfish species common to the Crisfield area are shown in Table C-18. Principal finfish common to the Crisfield vicinity are striped bass, white perch, spot and flounder. Blue crabs, oysters, and soft shell clams are the principal shellfish.

Natural oyster bars are located to the north at Daugherty Creek and Big Annemessex River and to the south at Little Annemessex River. All the waters of the Little Annemessex River upstream of a line running from Great Point to Long Point have been closed to shellfish harvesting since May 21, 1942. There are some crabbing bottoms to the north of Long Point and adjacent to the maintenance channel.

Waterfowl and Wildlife

Puddle ducks, diving ducks and Canada geese are the principal waterfowl species found in the Crisfield area. Blue wing teal and black ducks utilize the area for nesting. Unique wildlife such as the osprey and bald eagle are also known to use this area. Other users include ibis, egret, willet, gulls, terns, great blue heron, bittern, red shouldered hawk, marsh hawk, bobwhite quail and sandpiper. Mammals that occupy the area are muskrat, otter, opossum, skunk, fox, raccoon, mink, rabbit, squirrel, and whitetail deer.

Rare and Endangered Species

There are no known rare or endangered species of plants or animals indigenous to the immediate Crisfield area.

Wetland Types

Trapping, hunting, fishing and crabbing activities are supported by nearly 1,200 acres of wetlands located in the Crisfield study area. The bulk of these wetlands are owned by the state while the rest remain under private ownership. The Jersey Island area has approximately 400 acres of coastal salt meadow while Johnson and Horse Creek Marsh

TABLE C-17

INVERTEBRATES FOUND IN SOMERSET COUNTY

Copepods:		*Acartia clausi*
		Acartia tonsa
		Eurytemora affinis
		Oithona brevicornis
		Podon polyphymoides
Jellyfish:	Sea Nettle	*Chrysaora quinquecirrha*
	Winter Jellyfish (Lion's mane)	*Cyanea Capillata*
	Moon Jellyfish	*Aurelia aurita*
	Sea Walnut	*Mnemiopsis leidyi*
Clams:	Hard Clam (Quahog, Little Neck, Cherry-stone, or Chowder clam)	*Mercenaria mercenaria*
Oysters:		*Crassotrea virginica*
Oyster Predators:	oyster drills	*Urosalpinx cinerea*
		Eupleura audata
	Microparasites	*Haplosporidium nelsoni* (msx)
		Labryinthonyxa marinum (Dermo)
Crabs:	Blue Crab	*Callinectes Sapidus*

TABLE C-18

IMPORTANT FINFISH AND SHELLFISH SPECIES
COMMON TO THE CRISFIELD AREA

American shad	Alosa sapidissima
Alewife	Alosa pseudoharengus
Blueback	Alosa aestivalis
American eel	Anguilla rostrata
White perch	Morone americana
Striped bass	Morone saxatillis
Yellow perch	Perca flavescens
Bluefish	Potatomus saltatrix
Spot	Leiostomus xanthurus
Croaker	Micropogon undulatus
Weakfish	Cynoscion regalis
Atlantic silverside	Menidia menidia
Puffer	Spheroides maculatus
Winter Flounder	Pseudopleuronectes americanus
Hogchoker	Trinectes maculatus
Bay anchovy	Anchoa mitchilli
Hard clam	Mercenaria mercenaria
Blue crab	Callinectes sapidus

SOURCE: The Chesapeake Bay, Jane Lippson, 1973.

consist of nearly 800 acres of irregularly flooded salt marsh and coastal salt meadow. Dominant vegetative species for both areas are Juncus roemerianus, Spartina patens, Distichlis spicata, Ivas spp., Eleocharis spp., and Scirpus olneyi.

POCOMOKE CITY, MARYLAND

Pocomoke City is on the Delmarva Peninsula about 158 miles south of Philadelphia, 103 miles north of Norfolk, and 16 miles from the Atlantic Ocean. It is located on the east side of the Pocomoke River in the southwest part of Worcester County, about five miles from the Virginia state line. Baltimore (135 miles) and Washington (146 miles) can be reached in about three hours by U.S. highways 13 and 50, while Salisbury, the principal trading and service center for the lower Delmarva Peninsula, is 29 miles away.

Pocomoke City began as a small settlement on the Pocomoke River known as Stevens Ferry, later changed to Stevens Landing. When a log Presbyterian meeting house was established about 1680 the settlement became known as Meeting House Landing, then Warehouse Landing as the tobacco trade grew, Newtown from 1780 to 1818, and finally Pocomoke City. Steamboats arrived about 1850, expanding the market for timber products and stimulating the settlements along the river. Regular service was maintained to Baltimore and other ports. A railroad was built across the river at this point, extending northward to Philadelphia and southward to the lower end of the peninsula where trains were ferried to Norfolk. Now it is U.S. Route 13 that dominates the transportation picture for Pocomoke City but the river still serves commercial navigation and the railroad still fills an important need. Only an airport is lacking. For scheduled passenger service the nearest airport is at Salisbury, about 29 miles away. For private aircraft there is the Wallops Station airport, about 12 miles away, which belongs to the National Aeronautics and Space Administration (NASA) but is available to private users by special arrangement.

Today, Pocomoke City is a progressive independent community which has become the commercial center for a 20 mile radius. The City's diversified economy is based upon a substantial number of service and supply businesses, along with light industrial manufacturing plants. The City's progressive atmosphere is complemented by its comfortable residential areas. Surrounding the city are slightly rolling fertile farmlands and extensive forested areas, including some unusual cypress swamps along the river.

EXISTING RECREATION RESOURCES

Pocomoke State Forest contains about 13,000 acres and is located between Pocomoke City and Snow Hill. The Forest is famous for its stands of loblolly pine. The loblolly pine provides about half of all the timber cut in the State. Cypress swamps border the Pocomoke River, and the nearby waters provide good fishing.

The Pocomoke River, which has been designated by the State of Maryland as a scenic river, provides many recreational opportunities. Portions of this river are unique and beautiful; its shorelines are generally wild and uninhabited. The Pocomoke River abounds with black bass, pike, crappie, bluegill and striped bass. The river also provides excellent opportunities for hunting ducks and geese.

Pocomoke City has one public park, Winter Quarter Park, fronting on the Pocomoke River in the north part of town. The deed calls for 45 acres of land, however the adjacent river swamps increase the area to about 117 acres. Featured are a nine-hole golf course, a boat landing, a small zoo, a playground, picnic areas, and a log cabin for parties. The swamp area is heavily wooded with cypress and other hardwoods. The park is administered by a Park Board, and there is a golf club that maintains a club house for its members. The course is open to the general public.

Rather limited play areas are maintained on the four school grounds by the school authorities. They can also be used during non-school periods. There is a swimming pool for public use known as Merrill's Beach which is operated by the Lions Club and located across the river in Somerset County.

FUTURE RECREATION CONSIDERATIONS

General community parks and forests of up to 100 acres or more are necessary to accommodate the kinds of recreational activities that require spaciousness. Naturally wooded areas, the banks of streams, and other naturalistic features that need to be preserved and made available for the continuing enjoyment of present and future generations usually fall in this category. If acquired and preserved in their natural state, they can contribute immeasurably to the living qualities and property values in a community, whereas, if neglected, they often become expensive problem areas. They can be used for hiking, picnicking, horseback riding, camping, wildlife conservation, fishing, boating, golf, nature study, and many other activities. The following paragraphs present the recommendations and/or desires of local interests based on county and city planning documents.

Based on the current population of approximately 3,600 people and the minimum recreation standards discussed earlier, Pocomoke City should have at least 35 acres of public parks and playgrounds of various kinds in town, plus access to at least twice this amount in the nearby countryside.

If the population should increase in the next 20 years to approximately 5,200 as projected, the need will increase to at least 50 acres in town and still more on the outskirts. The existing 45 acres or so in Winter Quarter Park do not meet these requirements. The acreage is not distributed in different parts of town, and the property is devoted almost entirely to the golf course which serves only a very limited segment of the population. A more adequate system of recreation areas to serve the growing community as a whole is outlined in the Community Facilities Plan, the features of which are discussed below.

Meadow Lane Park. This is a woody and somewhat marshy area of six acres between U.S. Route 13 and the homes on Front Street and Linden Avenue. There is access by three narrow lanes, one of which is Meadow Lane. The property is landlocked and otherwise unsuitable for residential development, but would make a good neighborhood park for the older residential section between Market Street and the highway, serving also as a permanent buffer between the residential section and the road.

Riverfront Plaza. This is a proposal for a riverfront plaza next to the central business district, to replace a row of obsolete and unsightly sheds or warehouses. About one acre of land will be required between Market Street and Maple Street or beyond.

Proposed Elementary School "A". Construction of a new consolidated elementary school on the property between Seventh and Eighth Streets, south of Cedar Street, has been proposed. The present Stephen Long School would be dismantled and its site would be used as a neighborhood park and playground along with the rear portion of the new school site which it adjoins. The total area of these combined sites would be about 18 acres of which five acres would be needed for the school proper, leaving 13 acres for park and recreational use.

Winter Quarter Park. The swamps and woodlands, south of Greenway Avenue down to U.S. Route 13 west of the cemetery and including the pond, could be acquired and added to Winter Quarter Park so as to round out the area of public ownership in this bend of the river. It should be held primarily as a nature preserve. Limited recreational uses would be appropriate in the area consistent with conservation management. The enlarged park area would total about 190 acres of which approximately 50 acres are presently usable.

Town Branch Park. This general purpose park area of about 55 acres lies mostly in the county, with about nine acres inside the city limits. It would most likely be a county project, serving the growing residential areas northwest of the bypass but also serving the northeast part of town. It can be reached by way of U.S. Route 113 or by Linden Avenue. It includes the woods along two streams and some open land for intensive recreational use.

Pocomoke High School. This property should be extended west to the railroad tracks so that it can be developed as a full-fledged neighborhood park, school, and playfield. The eight acres of additional woods will increase the site to a total of 35 acres, of which 10 acres should be reserved for school use. The enlarged park, all heavily wooded, will protect the growing residential district to the north from the proposed industrial developments to the south, thus functioning as a neighborhood buffer strip in accordance with sound community planning principles.

Union Branch Park. The woods and swamps along this stream south of McMichael Avenue, including the two water-filled sand pits now stocked with game fish, could be acquired for community park and conservation purposes.

Proposed Elementary School "B". The School Plan recommends a new elementary school just east of town, across from the Pocomoke High School. If a modern site of 16 to 20 acres is acquired, part of it would be used as a playground and neighborhood park for this outlying area.

Upper Pocomoke Forest Preserve. The swampy bottomlands and woods along the river, upstream from Winter Quarter Drive, could be acquired by the County and preserved in its native state.

Sanitary Lagoons. When the sanitary lagoons are constructed on the property that the city has bought south of town, the fringes of the area could be left in natural woods for isolation and protection of the adjoining property. This will constitute a forest preserve for the conservation of game and other wildlife, covering about 140 acres of the existing 170-acre tract.

Within the present city limits, the above recommendations could produce some 219 acres of recreation areas. Approximately 80 acres of this area are suitable for intensive use with the remainder being in swamps and water area. Another 300 acres or more would

lie outside the city boundary and much of this, too, would consist of swamps and forest preserves. The total amount of usable land will be consistent with present and long-range demands from Pocomoke City and the surrounding territory, offering a variety of opportunities for different types of recreation activities. In addition, the recreation areas would be well distributed around the community so that no one would be more than one-half mile from some kind of recreation area. Three of these projects--Union Branch Park, Town Branch Park, and Riverfront Plaza--are carried in the Master Recreation Plan for Worcester County because of their general significance beyond the limits of Pocomoke City. The projects are listed above in the general order of suggested priorities on the basis of need, opportunity, or urgency of action.

ENVIRONMENTAL RESOURCES

Water Quality

The water quality in the Pocomoke River Basin is generally good. There are some localized problems mostly near the major population centers of Snow Hill, Princess Anne, Pocomoke City and Crisfield. The problems consist of overenrichment, oxygen depletion, and bacterial contamination. Non-point sources which contribute to these problems are failing septic systems, agricultural runoff and boating activities. Water from Pocomoke City's sewage treatment plant enters the Pocomoke River after treatment. Other point sources discharge into the river or into groundwater systems. These include the Pocomoke Truck Stop, Campbell Soup Company, and several motels.

Past water quality surveys have generally been conducted during the summer months and have shown low dissolved oxygen levels and high bacterial numbers for a large portion of the river, especially around Pocomoke City and Snow Hill. Samples taken at the water quality sampling station at Pocomoke City showed dissolved oxygen readings to be slightly below minimal acceptable values during the summer months. However, sampling during spring and late fall showed an increase. Chlorophyll "a" levels, average pH values, and nutrient concentrations were all within expected values except for a higher nitrate concentration during November. Fecal coliform numbers exceeded standards in all but one sample taken at this station.

Two intensive surveys, one in July and one in November 1976, were conducted for the purpose of obtaining input for modeling efforts. Overall, these surveys showed pH to remain consistently low, probably due to natural environmental conditions. Dissolved oxygen levels were low during the summer survey, but by November D.O. levels in most areas along the Lower Pocomoke River segment more than doubled. Fecal coliform numerical standards for Class I waters were exceeded during both surveys at many stations along the Pocomoke River mainstem and at all tributaries (especially Wagram Creek and Rehobeth Branch) that were sampled. This is probably a result of failing septic systems and, to some degree, animal husbandry practices. Two major problem areas were the waters around Snow Hill and, to a lesser extent, Pocomoke City. Nutrient levels showed what appeared to be a nitrogen limiting factor during the July survey and a phosphorus limiting factor during colder months. Concentrations of nutrients were low at all stations sampled in July whereas an increase of nitrates along the mainstem occurred during the later survey. This increase in the latter survey can be attributed to colder temperatures and decreased biological activity.

Four biological stations (two samples per station) were sampled from the mouth of Union Branch northward to the Route 12 bridge in Snow Hill. All four stations showed a diversity index of 1.5 or less. However, due to lack of previous biological data, conclusions cannot be drawn as to whether this is normal for the region due to natural conditions, or if it is a result of less than acceptable water conditions within the Pocomoke River.

Biota

Principal finfish common to the Pocomoke City area are largemouth bass, bluegill, sunfish, black crappie, and pumpkinseed sunfish. Wood ducks are known to use this area for nesting. Unique wildlife such as the bald eagle and osprey have been sighted near Pocomoke City. Mourning dove and woodcock are the principal upland birds. Shoreline birds consist of egret, bittern, great blue heron and green heron. Mammals commonly sighted in the area are muskrat, opossum, fox, skunk, raccoon, otter, rabbit, squirrel, deer, and bobwhite quail.

Rare and Endangered Species

There are no known rare or endangered species indigenous to the Pocomoke City area.

Wetland Types

Nearly 180 acres of wooded swamps are found in the Pocomoke City area at Union Bridge and along the Pocomoke River north of State Highway 13. These are privately owned areas which support activities such as rabbit hunting and fishing. This wetland habitat provides for numerous waterfowl, wildlife, and fishery species. A few examples of each include usage by puddle ducks for resting and feeding, but more importantly for wood duck nesting, brood production and nightly roosting. Other bird activities include migratory stops by mourning doves and woodcock, complete life cycle usage by great blue herons, egrets, ibis, killdeer, sandpipers, and large numbers of resident and migratory songbirds. Also, the bald eagle and osprey utilize this type for nesting sites. Deer, rabbit, squirrel, muskrat, otter, opossum, and fox also utilize this habitat. In permanently watered areas, there are several resident game fishes such as largemouth bass, pickerel, catfish, white perch, and yellow perch.

The dominant vegetative species are Baccharis halimifolia, Myrica cerifera, Zizania aquatica, Alnus spp., Typha spp., Acer rubrum, Fraxinus spp. and Polygonum spp.

The Moore's Pond area consists of approximately eight acres of inland open fresh water which is owned by the gravel company. Shallow water in artifical ponds, lakes and open areas interspersed in inland fresh marsh types categorize this wetland. Water depth is variable and this type is usually fringed by a border of emergent vegetation that grades into another type of wetland.

Vegetation consists of Potamogeton spp., algae, Typha spp., Salix spp., Alorus spp., and Nuphar spp. This type of wetland functions as resting and feeding areas for migrating waterfowl and other waterbirds and also as nesting and brooding grounds for wood ducks, black ducks and mallards. This habitat provides sustenance for fish, muskrats, turtles, frogs, salamanders and the animals that use the shoreline to prey on these inhabitants.

ROCK HALL, MARYLAND

The Town of Rock Hall is situated in the southwestern portion of Kent County. Kent County is located on the northern portion of the Delmarva Peninsula on the eastern side of Chesapeake Bay across from Baltimore. In addition to its western border on the Bay, the County is bordered on the north by the Sassafras River, on the east by the State of Delaware, and on the south by the Chester River.

Dating back to the early 1640's, Kent is Maryland's second oldest county, and it was the first county established on the Eastern Shore. Eastern Neck was the site of the first Eastern Shore settlement that endured. As this development was taking hold on the Chesapeake Bay, Philadelphia, New York, and Boston were being established to the north. These latter places, of course, have since become highly urbanized, while the farming and water-related activites characteristic of the original settlements survive on the Eastern Shore of Maryland.

In colonial times, travelers from the south crossed the Bay from Annapolis to Rock Hall, there to board the stage for Philadelphia and New York. The first news of the Revolutionary War victory over Cornwallis at Yorktown was carried through Rock Hall to the Continental Congress meeting in Philadelphia.

Today, Rock Hall remains dedicated to the fishing industry for which it was originally established, and, in addition, has developed as a center for boat building and maintenance. The Rock Hall Harbor and its surrounding areas are endowed with many natural resources. Since colonial times waterborne travelers have been attracted to Rock Hall's pleasant rivers, inlets and harbors due to the excellent opportunities they offer for fishing, crabbing, clamming, oystering and pleasure boating. Because of its scenic setting on Chesapeake Bay, its excellent seafood, and its own brand of tranquil Eastern Shore living, many tourists and prospective residents are attracted to the Rock Hall area each year.

Kent County lies within two hours driving time of more than nine million people. Preservation of the traditional tranquility of the Eastern Shore can contribute much to the cultural well-being of present and future inhabitants and visitors. The county in general and Rock Hall in particular have become pleasant places for water-oriented recreation or retirement. This combination of a peaceful waterfront view of the Bay and bucolic scenery suggests the substantial potential attractiveness of Rock Hall for both tourism and retirement minded people.

EXISTING RECREATION RESOURCES

Rock Hall Harbor and its surrounding areas are endowed with many natural resources. The harbor itself constitutes a natural resource in its use as a base for commercial and recreational activities such as fishing, crabbing, clamming, oystering, and pleasure boating. The harbor's size and potential for development are incentives to recreational boating activities within the State of Maryland and to out-of-state centers lacking equivalent facilities. Of particular importance is its favorable location to the many recreational and commercial activities in the Chesapeake Bay.

Goose hunting in Kent County is world famous. The Chester River and nearby areas attract more than 100,000 Canadian Geese each winter. The hunting of wild ducks, deer, and upland game also rates high among sportsmen. A National Wildlife Refuge is located at Eastern Neck Island, and Remington Farms is a wildlife management area near Rock Hall.

According to the Comprehensive Plan for Rock Hall, facilities for outdoor recreation are a key element. With increased leisure time and greater mobility, the demand for recreational facilities is growing at a faster rate than the population. People of all ages seek adequate areas for walking, pleasure driving, games and sports, swimming, sightseeing, picnicking, fishing, pleasure boating,, hunting, camping, and other recreational activities.

In the future planning for the Rock Hall area, public facilities for outdoor recreation can serve a two-fold purpose: (1) to provide opportunities for both active and passive recreation for the growing population of the town, and (2) to function as a basic industry for the community. Water-oriented activities are the most rapidly expanding aspects of outdoor recreation, and Rock Hall is uniquely suited to provide for these activities with its coves and inlets off Chesapeake Bay. Thus, the community has an opportunity to meet its local needs and, at the same time, develop a stronger economy based on tourism, vacationing, and retirement living.

Of prime importance in determining the community's potential for recreational development are the nearby metropolitan areas of Washington and Baltimore, which will have a combined population of over six million people by 1985. Since the completion of the Bay Bridge, linking Rock Hall directly with this metropolitan complex, the town has experienced unprecedented demands for both public and private recreational facilities.

Rock Hall presently has a variety of recreational facilities available for the use of its residents. Adjacent to the elementary school is a playground area of approximately six acres equipped with an apparatus area and a large well-graded playfield. The high school site has approximately 4.5 acres available for recreational use, although only a portion of this area is actually used (the undeveloped part was added to the school site only recently). In addition to these general recreation areas, there are eight public boat landings distributed along the waterways and inlets as listed in Table C-19. Some of these landings originated in earlier times when these waterways afforded the primary means of transportation, and they have been retained in active use in association with pleasure boating and fishing activities. Most of them, however, are nothing more than the point at which a public right-of-way touches the water, and there are no facilities available for putting boats into the water or for parking cars and trailers. This may change however as Rock Hall and Kent County have received permits to improve boat ramps and boat launching facilities.

The total recreation area provided by these facilities is 20.5 acres, which is approximately 9.5 acres per 1,000 persons based on the population of 2,150 persons residing in Rock Hall. (Results of the 1980 census indicate that the Town of Rock Hall has a resident population of 1,511 which translates into 13.5 acres per 1,000 persons.) This is slightly less than the recommended standard of 10.0 acres per 1,000 persons. Based on local planning documents, the principal facilities deficiencies are the lack of organized and adequate sports fields at the high school and the limited public facilities

available for pleasure boating enthusiasts. In the future, general recreation areas will need to be expanded to keep pace with the growing population. By 1985, the Rock Hall area may have as many as 4,100 people, requiring a total of approximately 41 acres devoted to public recreational activities—twice the present acreage.

TABLE C-19

PUBLIC BOAT LANDINGS AT
ROCK HALL

NAME OF LANDING	FACILITIES AVAILABLE
1. Allen's Lane	None
2. Bayside	Wharf, slips, repairs, gas, food
3. Gratitude	Ramp, slips, repairs, gas, food
4. Gray's Inn Creek	None, dirt trail access
5. Green Lane	None
6. Haven Road	None
7. Sharp Street	Wharf, slips, repairs, gas, food
8. Spring Cove	Ramp, dirt road access

FUTURE RECREATION CONSIDERATIONS

In order to meet the various recreational needs of the Rock Hall community, several kinds of public recreation areas are proposed for acquisition and development. Playgrounds are proposed adjacent to each of the elementary schools, with playground apparatus, paved areas, ballfields, and lawn area for use of the younger children of the town. To serve the needs of the older children and adults of the community, a combination park-playfield is proposed, expanding the present community park at the Civic Center. More complete facilities for various sports acivities are needed to supplement the present facilities at this location. The total recreation area provided by these proposed facilities would be approximately 33 acres.

Recreation trends indicate that an increasing number of people will be attracted to Rock Hall Harbor by the recreational opportunities offered by the nearby waters of the Chesapeake Bay. At present, the harbor is the only area in Kent County that offers such a diversity of services and facilities for the use of commercial fishermen and the recreational boater. These factors, combined with higher incomes and more leisure time, allow people to devote a large proportion of their time to recreation. With the steady increase in popularity of recreational boating, the demand for recreation and tourist facilities is expected to expand greatly in areas such as Rock Hall.

A number of public landings are proposed for development, both at present locations and at new locations along the protected waters of the Rock Hall area. Five of these landings represent a total area of approximately seven acres. At each landing, small park areas, boat ramps, and parking areas for cars and trailers would be developed. These public landings are in conjunction with the waterfront sections devoted to commercial marine activities, in order that those using the public ramps can take advantage of the restaurants and the boat service and repair facilities which are offered. Through this combined public and private usage of the waterfront more boating enthusiasts will probably be attracted to the Rock Hall area to the benefit of the entire community's economy. Some of these proposals are being pursued as both Rock Hall and Kent County have received permits to improve boat ramps and boat launching facilities.

The town's residents should also encourage the preservation of those natural features which will aid the local economy by attracting vacationers and seasonal residents to the Rock Hall area. Of prime importance are Gray's Inn Creek and the marsh areas along the Bay, which should be preserved for their scenic qualities and for the more informal forms of recreation which they might offer -- walking, picnicking, and nature study.

ENVIRONMENTAL RESOURCES

Water Quality

Water quality in Rock Hall is not good. Water pollution in this area has been given as a reason by the Maryland Department of Health and Mental Hygiene for closure of shellfish beds offshore since 1964. A number of factors contribute to the degradation of water quality.

Sewage disposal in this area of poorly drained soils and limited financial resources is a problem. Sewage has been disposed of over the years by means of private subsurface disposal systems (septic tanks) or by disposal directly into ditches or drainage courses which eventually outlet into the harbor. The high water table and poor soil conditions often made septic tank installations unsuitable.

A sewage collection and treatment system has been built which provides service to all properties within the Rock Hall town limits and allows some additional capacity to accommodate future urban growth. Treatment is furnished by means of a stabilization lagoon located on a 60-acre parcel north of the town. Additional lagoons could be provided as the need arises.

Another source of pollution in the harbor may be anti-fouling agents consisting of toxic chemicals and elements such as copper which are used on boat hulls for prevention of the attachment of sessile organisms. Some releases from vessel sewage holding tanks may also occur.

Entry of fish processing waste is a possible cause of nutrient enrichment in the eastern section of the harbor. The Rock Hall Clam and Oyster Co., Inc. located near the County wharf has a permit to empty fish processing wastes through an outfall into the harbor.

Biota

Plankton

Distribution of autotrophic phytoplankton in the Chesapeake Bay can be estimated by concentrations of a type of chlorophyl designated as chlorophyl "a" in the euphotic zone, measured in milligrams per cubic meter of water. A fairly uniform distribution of 1-20 milligrams per cubic meter is found throughout the Bay in winter. Concentration of phytoplankton occurs in the upper Bay, including Rock Hall Harbor, during the summer. The summer concentration of chlorophyl "a" in the euphotic zone in the upper Bay may reach 100 milligrams per cubic meter of water and average between 30 and 60 milligrams/cubic meter. Some representative types of phytoplankton in the Bay according to Lippson, 1973, are: the diatom (Chaetoceras affinis), the dinoflagellate (Gymnodinium splendens), the yellow-brown algae (Chrysochromulina chiton), blue-green algae (Anacystis spp.) and the green flagellate (Carteria multifilis).

Zooplankton species in the Bay are chiefly microscopic crustaceans of the order Copepods. Although there are about 30 species of copepods in the Bay, only a few make up the major portion of the standing crop (Lippson, 1973). Acartia tonsa, Acartia clausi, and Scottolana canadensis are dominant copepod species in Rock Hall Harbor, their occurrence reflecting seasonal salinity variations. Another microscopic crustacean, the Water flea (Padon polyphemoides), occurs in Rock Hall Harbor in high densities from October through February.

Macroinvertebrates

Jellyfish, brackish water clam (Rangea cuneata), and blue crab (Callinectes sapidus), are macroinvertebrates found in shallow water areas of Rock Hall Harbor. Some soft-shelled clams (Mya arenaria) are found in the harbor but the greatest number are found on offshore bars. Oysters (Crassostrea virginica) have been seeded on offshore bars. Hard clams (Merceneria merceneria) are not comm[illegible] in this area of low salinities.

Jellyfish are gelatinous animals that drift with the currents. The sea nettle (Chrysaora quinquecirrha) will thrive when salinities are above five parts per thousand (ppt). Moon jellyfish (Aurelia aurita) and winter jellyfish (Cyanea capillata) while not as common as the sea nettle, are also found in Rock Hall Harbor.

Brackish water clams are not harvested. They are found in the harbor where the low salinities are conducive to growth. The shoft-shelled clam may be found in the sandy bottoms of the harbor but not in high densities. A clam bed is found to the west offshore of the harbor overlapping portions of three oyster bars, "Muddy Drain," "Windmill Flats," and "Huntingfield." The clam bed area is estimated to be 85 acres. Commercial concentrations are generally confined to the area of the Bay south of the Chester River. The commercial importance of this bed is, at present, negligible.

Huntingfield, a large oyster bar of 400 acres, is directly adjacent to the southwest end of the entrance channel to the harbor and has been seeded. While this may be the case, it should be pointed out that the Maryland Department of Health and Mental Hygiene has noted that the bars cited above as well as those in the Haven have been closed to harvesting since 1964. The Department samples the oyster bars around Rock Hall Harbor

as it does all known oyster bars in Maryland waters. Water pollution problems have been offered by the Department as the reason for closure of oyster bars in the area. While the cited oyster bars are not of commercial importance, the preservation of oyster communities on these bars is not to be overlooked since oysters are important to the ecology of the Bay.

June to September is the critical period when oyster spat begin to settle and attach themselves to shells and rocks in order to satisfy substrate needs. Dependent on the extent of sedimentation, the severity of winds, and the stability of sediments on these bars, oyster spat will or will not have the opportunity to settle. The fact that the area has to be seeded indicates that present environmental conditions do not promote ample regeneration of the oyster community on the bars outside of the Rock Hall Harbor.

Finfish

Rock Hall Harbor serves as a nursery area for finfish. The major nursery areas are the saltmarshes on the inside of breakwaters which provide a protected and filtered environment. Coordination with the Maryland Fisheries Administration reveals that Rock Hall Harbor is not an important area for spawning activity.

Numerous finfish species utilize the harbor area. Based on a survey conducted by the Maryland Department of Natural Resources in 1973, a total of 55.6 lbs/acre of fish were collected by trawl and seine in Rock Hall Harbor. The predominant species were spot (*Leiostomus xanthurus*), silversides (*Menidia spp.*), and white perch (*Morone americana*).

Wildlife

The Rock Hall area is heavily utilized by Atlantic Flyway migratory waterfowl. Records from the mid-winter waterfowl surveys conducted by the Fish and Wildlife Service provide information on waterfowl utilization in the Chester River area of which Rock Hall may be considered a part. Table C-20 presents waterfowl survey data for a wide variety of species for the years 1974 and 1975. Table C-21 provides average data for several species found. As can be observed, there are wide variations in species availability from year to year. Geese and swans constitute almost 90 percent of the waterfowl in the Chester River area. Ducks make up the remaining 10 percent. Table C-22 indicates duck species composition and their percentage of the total duck population. Table C-22 also presents the predominant food utilization of these species. As can be observed from Table C-20 the numbers of diving ducks varied such that over the two year period no pattern could be ascertained.

Wading birds which may be found occasionally in the Rock Hall Harbor are green herons (*Buteroides virescens virescens*), great blue herons (*Ardea herodeas*) and terns (*Sterna spp.*). Ospreys (*Pandion halioetus carolinensis*) prey on fishes found in the waters adjacent to the saltmarshes. Game animals which may be found on land adjoining the harbor are whitetail deer, rabbits, squirrels, and bobwhite quail. Furbearers include opossum, skunks, fox, raccoons and muskrats. The latter are much in evidence by their burrows in areas of dredge material deposition.

TABLE C-20

WATERFOWL SURVEY DATA-CHESTER RIVER AREA
(1974 and 1975)

SPECIES	NUMBER OF BIRDS	
	1973-1974	1974-1975
Mallard	3,900	1,200
Black Duck	2,300	1,500
Pintail	100	FEW
Total Puddle Ducks	6,300	2,700
Redhead	500	100
Canvasback	5,900	2,400
Scaup	1,100	10,100
Ringneck	FEW	----
Goldeneye	800	1,000
Bufflehead	200	100
Ruddy	100	1,400
Total Diving Ducks	8,600	15,100
Old Squaw	100	---
Merganser	FEW	FEW
Snow Goose	FEW	---
Blue Goose	FEW	---
Canada Goose	159,300	138,000
Coot	1,000	----
Whistling Swan	7,300	4,100

SOURCE: Regional Director, Fish and Wildlife Service,
U.S. Department of the Interior, Boston, Massachusetts, March 1975.

TABLE C-21

FIVE YEAR AVERAGES OF MID-WINTER WATERFOWL
SURVEY DATA FOR THE CHESTER RIVER AREA

SPECIES	NUMBER OF BIRDS	
	1964-1968	1969-1973
Canvasback	3,720	1,340
Redhead	300	----
Scaup	680	160
All Divers	9,060	3,000
Canada Goose	76,080	122,600
Whistling Swan	6,840	6,000

SOURCE: Regional Director, Fish and Wildlife Service,
U.S. Department of the Interior, Boston, Massachusetts, March 1975.

TABLE C-22

DUCK SPECIES COMPOSITION
AND PRIMARY FOODS
(Chester River Area)

SPECIES	PERCENTAGE OF TOTAL	PRIMARY FOODS
Scaup	33%	Invertebrates (mostly mollusks), submerged aquatic plants
Canvasback	25%	invertebrates (mostly mollusks), submerged aquatic plants, seeds of submerged aquatics
Mallard	15%	seeds, grains, submerged aquatic plants
Black Duck	11%	submerged aquatic plants, seeds, invertebrates
Goldeneye	5%	fish, invertebrates, rooted aquatic plants
Ruddy	4%	invertebrates (mostly mollusks)
Redhead	2%	submerged aquatics, seeds
Bufflehead	1%	invertebrates (mostly mollusks), submerged aquatic plants

NOTE: Totals do not sum to 100 percent because several other species, which are not presented, account for the difference.

SOURCE: Regional Director, Fish and Wildlife Service, U.S. Department of the Interior, Boston, Massachusetts, March 1975.

Rare and Endangered Species

The presence of endangered species in the vicinity of Rock Hall Harbor is a possibility. The species cited as possible inhabitants in the general area of the Eastern Shore known to have token populations are the Southern bald eagle (*Halioeetus leucocephalus*), the Delmarva Peninsula fox squirrel (*Sciurus niger cinerius*), the Eastern tiger salamander (*Ambystoma tigrinum tigrinum*), and the Arctic peregrine falcon (*Falco peregrinus tundrius*). Although there has been some consideration given to placing ospreys on the rare and endangered species list, this species has not been added.

Wetland Types

Wetland types found in the immediate area of Rock Hall include the coastal shallow fresh marsh and the coastal salt meadow. Of the two, the coastal salt meadow dominates with approximately 300 acres of marsh located near Rock Hall Harbor, Huntingfield Point, and Gray's Inn Creek. The areas are in private ownership and are used primarily for fishing and hunting purposes with residential and agricultural land uses bordering them. Vegetation consists mainly of saltmeadow cordgrass, saltgrass, and blackrush in combination with patches and/or borders of saltmarsh cordgrass. These areas are also lightly used by various wildlife, waterfowl, and fisheries.

The coastal shallow fresh marsh is located along Swan Creek and the Haven just north of Rock Hall Road. The approximately 80 acres that have been identified as under private ownership are used for trapping, fishing, and hunting purposes. Bordered exclusively by residential development, the vegetation consists mostly of cattail, reed, big cordgrass, three square marsh grass, and saltmarsh cordgrass. This area is heavily used for feeding by waterfowl, shorebirds, and waders and receives some feeding usage by muskrats, raccoons, and nutria.

Soils and Vegetation

The Rock Hall Harbor area is comprised of four types of substrate. A large portion of the area has been reclaimed from coastal submergence and subsequent marsh formation. Upland areas where submergence did not occur following the last glacial melting are mantled with developed soils. Areas of the southwestern, southeastern and eastern harbor littoral zone are subject to tidal overflow and sediment deposition and thus, are occupied by saltmarsh. The remainder of the harbor bottom is largely sand and silt material (mud) found offshore of developed harbor frontage.

The predominant soil group in this area of the County is the Elkton-Othello soil association. The Elkton soil series consists of deep, poorly drained soils having a gray, mottled fine-textured subsoil that is slowly to very slowly permeable. The Othello series consists of poorly drained soils developed on silty deposits underlain by beds of sandy silt and clay. All three series have similar profiles, but the subsoil is dominantly silt in the Othello soils, is fine silty clay or clay in the Elkton series, and is sandy clay loam in the Fallsington soils. All soils tend to be wet and require tile drainage. These soils are, generally, strongly acid. Rock Hall area soils may be contrasted with soils of a large part of the County which are well-drained and noted for their agricultural productivity. Loblolly pine, wetland hardwood, grasses, and forbs are the predominant vegetation. The

poorly drained nature of the soils does not lend to the success of hardwood species found in other sections of the County.

Much of the shoreline of Rock Hall Harbor has been reclaimed from coastal wetland having "Tidal marsh" and "muck" soil designations. However, some remnants of shoreline coastal wetlands may be found in Rock Hall Harbor. Remnants of coastal salt meadow are found along the eastern and southeastern harbor shore. Salt meadow hay (Spartina patens), saltgrass (Distichlis spicata) and patches of saltmarsh cordgrass (Spartina alterniflora) characterize the marsh. The soil is waterlogged during the growing season but the elevation is such that the area is rarely covered by tidal waters. The marsh may be inundated by a few inches of water at spring or high tide. The saltmarsh on the harbor side of the saltmeadow is covered more frequently by tidal waters. The dominant vegetation is big cordgrass (Spartina cynosuroides) and to a lesser extent, saltmarsh cordgrass (Spartina alterniflora). Other closely associated plants are saltgrass (Distichlis spicata), hightide bush (Iva frutescens) and wax myrtle (Myrica ceriferay). This type of saltmarsh is found in close association with the breakwaters.

Submerged aquatic grasses grow in the shallow waters of the harbor and in channels coursing through the saltmarshes. The aquatic plants characterizing this type of substrate are widgeon grass (Ruppia maritima), watermilfoil (Myriophyllum spp.), redhead grass (Potamogeton perfoliatus), sago-pond weed (Potamogeton pectinatus), wild celery (Valisneria americana), and common elodea (Elodea canadensi). Along most of the shoreline aquatic plants have not become sufficiently dense to limit or restrict water use by physical obstruction or to contribute to oxygen depletion through eutrophication. Along the eastern shore of the harbor, however, there is a tendency toward eutrophication.

SNOW HILL, MARYLAND

Snow Hill is on the Delmarva Peninsula, about 105 miles southeast of Baltimore, 115 miles north of Norfolk, and 12 miles from the Atlantic Ocean. Located on the Pocomoke River approximately 30 miles upstream from the river's mouth, Snow Hill functions as the county seat of Worcester County.

Snow Hill was founded in 1642 by a small group of settlers. The settlement grew and prospered as a farming community, with the river playing a key role in its development. In 1694 it was made a Royal Port, and schooners plied the river, carrying on a lively trade. Warehouses, a wheelwright and shipwright, and other supportive businesses prospered . By 1754 the population had grown and when Somerset County was divided into Worcester County and Somerset County in 1742, Snow Hill was made the county seat of Worcester County. In 1793 the town was subdivided into some 100 lots. Snow Hill was involved in the American Revolution and in June 1775 adopted resolutions to aid Massachusetts. Local records were hidden during the War of 1812. Both northern and southern sympathies were evident during the War between the States.

As steamboats replaced the schooners, Snow Hill continued as an active port carrying passengers and goods to the Western Shore. Steamers traveled upriver to the Nassawango Iron Furnace for shipments of bog iron. As the railroad superseded water travel, Snow Hill maintained an active role, as the rail line ran through town on the main north-south peninsular route.

In 1893 a disastrous fire destroyed the original downtown area, and the early town and county records housed in the Courthouse. Thus many of the facts concerning early Snow Hill are unable to be validated.

Snow Hill today still functions as the Worcester County Seat, with the Courthouse the nucleus of much activity. Small businesses are available to serve the needs of Snow Hill and the surrounding agrarian interests. Much emphasis is placed on maintaining Snow Hill with its quiet, brick sidewalks and tree lined streets, enriched by lovely old houses, without repressing a vitality and energy that is a real part of the town.

Snow Hill enjoys a number of natural amenities which should be conserved. In general, the community has a quiet, restful environment which is relatively free of air, water and noise pollution problems. The Town's unique natural environmental setting created by its location adjacent to the Pocomoke River and a relatively small population, which has located in a rather compact land area, adds much to the overall scenic attractiveness of the Town. The substantial number of historic structures clustered in a small area provides the community with a man-made asset which is difficult to duplicate. The town itself has an atmosphere of peaceful and comfortable living. There are fine old homes which date from the early 1700's. This is also the site of the first regularly organized Presbyterian Church in America, established in 1684. It is an attractive community for retirement living in particular.

EXISTING RECREATION RESOURCES

There are a variety of recreation programs offered for residents of all ages throughout Worcester County. The programs include sports, arts and crafts, swimming, and physical fitness. The opportunities for hunting in the County are almost unlimited. In the Pocomoke Forest small upland game and deer are plentiful. The Pocomoke River offers one of the best areas on the East Coast for catching bass, pike, crappie, and bluegills.

Shad Landing State Park contains about 545 acres and is located about four miles southwest of Snow Hill off Route 113 in the Pocomoke State Forest. The area was once a refuge for Civil War deserters, and ships laden with contraband sought haven along the Pocomoke River which borders the park. Facilities include an olympic-size swimming pool, marina, tables, fireplaces, play areas, and extensive camping facilities.

Milburn Landing State Park contains about 370 acres and is located about eight miles west of Snow Hill off Route 12 in the Pocomoke State Forest. The Pocomoke River flows through the picturesque park area which features camping, picnicking, hiking, and fishing, as well as being a haven for birdwatchers.

Snow Hill has one public park of about 16.5 acres (Byrd Park) located on the riverfront on the south side of Town. It has a good variety of facilities, including a lighted ball diamond, boat slip, launching ramp, small zoo, picnic and camping areas, and fishing banks along the river. Part of the property was being used as a public dump, but this low spot has now been filled and will be available for further park development.

Byrd Park is part of a larger piece of property purchased by Snow Hill some years ago to provide the right-of-way and a disposal area for the dredging of a navigation channel by the Corps of Engineers. Some of the property along Cypress Avenue was sold for an

industrial plant and the part south of Cypress Avenue was retained for the Town garage and sewerage disposal plant. Still another part was cut off by the channel and remains as an 8.5 acre island which is inaccessible and unused. It can continue to serve as a bird sanctuary, while the park proper should continue to be more developed with additional facilities. Emphasis should be given to the water features with additional boat facilities of various kinds.

FUTURE RECREATION CONSIDERATIONS

The following paragraphs were taken from local planning documents to include the County Master Plan and are representative of the recommendations and/or considerations of the local interests relative to recreation needs and development.

Residents of Worcester County wish to preserve natural stream valleys throughout Snow Hill and adjoining County areas. These areas provide a natural drainage system and are potential recreational areas which can be used as a buffer between diverse land uses. These stream valleys should be preserved before they are developed or before they become too expensive to acquire. The valleys make an attractive setting for small neighborhood parks which serve adjoining residential areas. Several of the areas considered for retention as natural and scenic parks are discussed below.

Patty's Branch Park and Forest Preserve. The wooded and partly marshy strip along Patty's Branch and Purnell Branch, from Route 12 to the Pocomoke River, is a part of the County Master Plan that will help in meeting the future needs of Snow Hill as it expands to the east and north. This strip is also the corridor for an electric transmission line and the future U.S. Route 113 beltway, as well as the outer limit of the primary sewer service area. Development plans may include a wayside park on U.S. Route 113 near Church Street where there is high ground, and a general community park for Snow Hill and vicinity around a pond in the woods north of Washington Street. The swampy and marshy portions nearer the river are unsuitable for intensive use and could be preserved as natural areas for the conservation of wildlife, natural forest growth, water control and related recreational activities.

Pocomoke Forest Preserve. Another area of cypress swamps and marshes along the river on the north side of Town is recommended for retention as a nature preserve of about 50 acres. It offers a fine example of the characteristic Pocomoke River ecology, valuable for its educational and special recreational uses.

Dighton Road Forest Preserve. This small area of about 30 acres on the Pocomoke River just below the sewage treatment plant is unsuitable for residential development and could be retained as a buffer strip to protect the future residential areas along the river to the south. It is dry land, mostly wooded, and is reported to contain an old cemetery which might be expanded for future needs.

General community parks and forests of up to 100 acres or more are necessary to accommodate the kinds of recreational activities that require spaciousness. Naturally wooded areas, the banks of streams and other natural features that need to be preserved and made available for the continuing enjoyment of present and future generations, usually fall in this category. If acquired and preserved in their natural state, they can contribute immeasurably to the living qualities and property values in a community,

whereas if neglected they often become expensive problem areas. They can be used for hiking, picnicking, horseback riding, camping, wildlife conservation, fishing, boating, golf, nature study, and many other activities.

It has long been the practice of recreation and planning authorities to recommend at least ten acres of urban recreation space of all kinds for each 1,000 persons, or ten percent of the gross land area in the community. These in-town recreation areas should be in about the following proportions: playgrounds, 1.25 acres per thousand persons; playfield, 1.25 acres; small parks 2.25 acres; and major parks, 5 acres. These are minimum standards and should be exceeded if possible. Additional areas should be provided outside of town on a more extensive scale, either by the community or by County or other governmental authority.

For its current population of almost 2,200 people (1980 population of 2,192), Snow Hill should have at least 22 acres of park and playground space in town, plus access to twice this much in the nearby countryside. If the population should increase in the next 20 years to 2,600, as projected, the need will increase to at least 26 acres in town and still more on the outskirts. Specific recommendations for meeting this need as presented in the County Development Plan include:

Snow Hill High School Playfield. If the recommendations are carried out for rebuilding the high school on the Church Street properties, there will be a total site of 30 acres in the heart of Town, of which about 20-25 acres will be needed for the school buildings and lawn, leaving 5-10 acres for park and playground uses. This is enough to provide for a limited variety of neighborhood recreation facilities and some flexibility in their use.

Ross Street Playground. The former Ross Street school site could be developed as a public playground and small neighborhood park serving the south side of town. If the site is developed for housing, the park could be on the middle school property.

Timmons Street Playground. To serve the north side of town, there should be a playground of from 4-7 acres. The suggested site is an old field behind the houses on Bay Street, with some limited frontage on Bay Street and access also from Timmons Street, Federal Street and Park Row. The site is large enough to include some park planting as well as open play space.

J. Walter Smith Park. The County has acquired an 88-acre site for a community park located on Bay Street to the west of town near the intersection of Alternate Route 113. The facility, currently in its planning stages, will contain two softball diamonds, a little league baseball park, tennis courts, basketball courts, shuffle board areas, picnic areas and parking facilities. The development of the park by the County should provide adequate general recreation areas in the Snow Hill area to accommodate local needs through and beyond 1990.

ENVIRONMENTAL RESOURCES

Water Quality

The Lower Pocomoke River segment includes approximately the lower 37 miles of the Pocomoke River and all of its tributaries except Dividing Creek and Nassawango Creek.

The river has been designated a scenic river, one of the few within Maryland, and should undergo little further development along its banks.

Pocomoke City and Snow Hill are the only major towns located in this segment. Both towns have central sewage treatment plants (STP) with Snow Hill having yet to upgrade its primary treatment facility. All wastewater, after treatment from both STPs, enters the Pocomoke River. Other point sources discharge into the river or into groundwater systems. These point source discharges include Holly Farms Poultry industries, Pocomoke Truck Stop, Campbell Soup Company, and several of the motels located at Pocomoke City.

Past surveys have mainly occurred during the summer months and have shown low dissolved oxygen levels and high bacterial numbers for a large portion of the river especially around Snow Hill and Pocomoke City. Results from 1976 indicate similar findings. Samples taken at the Snow Hill water quality sampling station showed that generally all Class I standards for dissolved oxygen, pH, turbidity, and fecal coliform values were met except for an occasional isolated instance. High chlorophyl "a" concentrations were found in samples taken during June and July.

Two intensive surveys, one in July and one in November 1976, were conducted for the purpose of obtaining input for modeling efforts. Overall, these surveys showed pH to remain consistently low, probably due to natural environmental conditions. Dissolved oxygen levels were low during the summer survey, but by November D.O. levels in most areas along this segment more than doubled. Fecal coliform numerical standards for Class I waters were exceeded during both surveys at many stations along the Pocomoke River mainstem and at all tributaries (especially Wagram Creek and Rehobeth Branch). This is probably a result of failing septic systems and to some degree, animal husbandry practices. Two major problem areas were the waters around Snow Hill and, to a lesser extent, Pocomoke City. Nutrient levels showed what appeared to be a nitrogen limiting factor during the July survey and a phosphorus limiting factor during colder months. Concentrations of nutrients were low at all stations sampled in July whereas an increase of nitrates along the mainstem occurred during the later survey. This can be attributed to colder temperatures and decreased utilization by the biota and not to increased agricultural activities. Chlorophyl "a" concentrations showed low values during both surveys except for higher values around Snow Hill during July.

Four biological stations (two samples per station) were sampled from the mouth of Union Branch northward to the Route 12 bridge in Snow Hill. All four stations showed a diversity index of 1.5 or less. However, due to lack of previous biological data, conclusions cannot be drawn as to whether this is normal for the region due to natural conditions, or if it is a result of less than acceptable water quality conditions in the Pocomoke River.

Biota

Principal finfish common to the area are largemouth bass, black crappie, striped bass, branch herring, hickory shad, white shad, pickerel and channel catfish. Puddle ducks utilize this area for nesting as well as feeding. This area is also utilized by wood ducks. Upland birds consist mainly of mourning dove and woodcock. Principal shoreline birds

are great blue heron, gulls and killdeer. Principal mammals in the area are rabbit, opossum, skunk, fox, deer, raccoon, bobwhite quail, and squirrel.

The Snow Hill area provides suitable habitat for bald cypress, Taxodilum distichum. Areas in Maryland and New Jersey are the northern most extent of the bald cypress range.

Rare and Endangered Species

There are no known rare or endangered species of plants or animals indigenous to the Snow Hill area.

Wetland Types

Snow Hill contains nearly 430 acres of wetlands consisting of wooded swamps and coastal shallow fresh marshes, all of which are privately owned. Wooded swamps which support activities such as deer hunting and fishing are located at Nassawango Creek, along the Pocomoke River, Purnell Branch and Campground Branch. Vegetation consists mainly of trees to include cypress, pine, cedar, gum, maple, ash, poplar, beech, willow and alder.

Coastal shallow fresh marshes occur along the Pocomoke River, Purnell Branch and Campground Branch. These areas are heavily used for feeding by waterfowl, shorebirds and waders and receive some feeding usage by muskrats, raccoons and nutria. Dominant vegetative species are cattail, three square marshgrass, arrow-arum, arrowhead, big cordgrass, and spatter-dock.

ST. MICHAELS, MARYLAND

The Town of St. Michaels, and indeed all of Talbot County, lies wholly within the Atlantic coastal plain region. The town itself is located on a narrow, irregularly shaped peninsula jutting out into the Chesapeake Bay between the Miles River to the north and the Choptank River and its estuaries to the south. The town has an ideal natural harbor opening on the Miles River, as well as access to the Choptank River via San Domingo Creek on the south side of town. Only 1,500 feet of land in the center of town separate the harbor from San Domingo Creek at the point of maximum proximity.

Located in the western part of Talbot County, St. Michaels was settled some time in the early part of the 17th century. The earliest record mentioning St. Michaels by name is dated 1680, but the settlement existed long before that date. Bounded on one side by the Miles River, on the other by San Domingo Creek, and surrounded by forest, it is not surprising that St. Michaels became a shipbuilding center by the late 17th century. The location was also well suited for overseas trade and during the 18th century St. Michaels was a port of considerable importance. Because of the importance of the town as a shipbuilding center, the British attempted to destroy it during the War of 1812. Their lack of success in this endeavor has created much of the historical significance the town enjoys today.

The seafood industry has also played an important part in the development of St. Michaels. From the mid-19th century until a few years ago the seafood industry was the center of the town's economic activity. With the advent of high speed highway

transportation, St. Michael's traditional waterborne commerce with the urban areas of the State has practically vanished. However, the traditional links to the water remain with the development of the town as a yachting center. Although the town now finds itself somewhat remote from the urban areas of the State, it exhibits a slow but steady growth.

Even with the increase in the residential density of the waterfront areas of St. Michaels, the land has remained basically agricultural in nature. St. Michaels, rich in a culture and a way of life dating back to the 17th century, is today progressive and ambitious, but still retains many landmarks and social customs which are its inheritance. The visual elements provided by St. Michaels' location on Chesapeake Bay in combination with the low density residential areas and quiet rural atmosphere are considered to be worth preserving by the citizens of St. Michaels.

EXISTING RECREATION RESOURCES

Talbot County has about 600 miles of waterfront on the Chesapeake Bay and its tributaries. Five rivers--the Miles, the Wye, the Choptank, the Tred Avon, and the Tuckahoe--and countless streams and creeks crisscross the county providing varied opportunities for recreation. Sailing, boating, fishing, swimming, and water skiing are among the activities available in the area. During the fall and winter months, hunting and trapping are popular activities. Waterfowl, small game animals, and deer attract many hunters each year.

The Chesapeake Bay Maritime Museum located in St. Michaels also provides recreational opportunities for residents as well as out-of-town visitors. The museum in conjunction with the waterfront restaurants, the general historical lure of St. Michaels, and the marine facilities have increased tourism in St. Michaels.

The popularity of St. Michaels as a yachting center is well known. The town is a favorite terminus for many cruises and races. Although the waterfront facilities are reasonably good, many large groups of boats anchor in Long Haul Creek, partially because of the yacht club, but more importantly, because of the shoal conditions in much of St. Michaels Harbor.

There are just a little over two acres of parks in St. Michaels; unfortunately only about half of this has access to the water. Since the town itself is almost 30 percent undeveloped and is surrounded by large agricultural tracts, the lack of park space is not a problem at the present time. However, as the land is developed this lack may be felt. Inadequate access to the water could serve to deter the use of the town harbor in the future by yachts and boats. However, according to some residents of St. Michaels, this consideration must be approached with some caution as access to the water has caused, what amounts to, a public nuisance in some areas.

The town has a community center known as Redman's Hall which is used on an "as required" basis for various functions. The structure is of adequate size but some upgrading of appearance and equipment is desirable.

Special events in St. Michaels include log canoe races and St. Michaels Days. The only remaining fleet of 17 log canoes (most based at St. Michaels) race there each weekend

during the summer. St. Michaels Days is an annual festival held in September and features water-oriented activities of the town - boat parades, races, antique shows, exhibits, a play, street parades, and tours.

FUTURE RECREATION CONSIDERATIONS

Included in the land use plan for St. Michaels is a provision for a substantial increase in parks, recreation areas, and public and semi-public lands. The extent of this increase, however, is not defined in the Comprehensive Plan. St. Michaels does appear to have an adequate supply of undeveloped land that can be used for this purpose. Local interests consider it important that the town obtain additional access to the water. To this end additional park spaces should be acquired both on the harbor and on the river.

According to the Comprehensive Plan for St. Michaels, the residents wish to preserve and enhance the special aura which is unique to this waterfront town on the Eastern Shore; and to provide a balanced community in which industry, commerce, recreation and residence blend into a harmonious whole. The town will continue to encourage tourism by supporting such facilities and attractions as are consistent with the quiet residential quality of the town.

ENVIRONMENTAL RESOURCES

Water Quality

According to the 1977 Maryland Water Quality Survey, water quality at the monitoring station near the mouth of the Miles River showed an increase in all nitrogen compounds when compared to 1975 monitoring data, but no change in other parameters. From intensive survey data, nutrients in the mainstem of the river were found to increase in an upstream direction. Dissolved oxygen generally decreased from the mouth of the river upstream, but did not fall below the State water quality standards for dissolved oxygen. There was no change in bacterial quality, consequently Miles River remains closed to shellfish harvesting in the upper river.

In the tributaries, the freshwater sections of Potts Creek, Goldsborough Creek and Glebe Creek had high bacterial values in 1976, which is indicative of a violation of the Class I water quality standards. In the lower watershed, Oak Creek, St. Michaels Harbor and Leeds Creek were relatively high in organic nitrogen.

Numerous fish kills have been observed in St. Michaels Harbor. The conditions in the harbor seem to be related to three potential non-point sources: (1) failing septic tanks, (2) boat and marina wastes, and (3) urban and agricultural runoff. Bacterial conditions in the tributaries should improve with the completion of the new St. Michaels sewage treatment plant.

Biota

The most significant wildlife habitats in the county are in the areas on and adjacent to the more than 600 miles of shoreline. The shallow areas of the river and bays serve as spawning grounds for many species of fish and provide nourishment for young animal

forms, protecting them from predators and rough water. The marsh areas generate organic nutrients which constitute vital links in the food chains of the Bay.

Invertebrates and Finfish

Blue crabs, soft shell clams, and oysters are found in St. Michaels' waters. In the past St. Michaels was known to have some of the largest blue crabs in the Chesapeake Bay area. Two oyster bars, Ash Craft and Old Orchard, lie just outside the entrance to St. Michael's Harbor. Principal finfish species that may be found in the waters around St. Michaels are striped bass, spot, weak fish, white perch and yellow perch.

Waterfowl and Wildlife

Waterfowl in the area consists of puddle ducks, diving ducks, Canada geese and whistling swans. Osprey are known to utilize the area for nesting. Mourning doves and woodcocks are among the migratory game birds to inhabit the area. Shorebirds and waders include gulls, great blue heron, killdeer, sandpipers, and egrets. The bobwhite quail, an important upland game species, can also be found there. Principal mammals in the area are deer, rabbit, squirrel, raccoon, opossum, skunk and fox.

Rare and Endangered Species

The Delmarva fox squirrel (Sciurus niger cinereus) and the Southern bald eagle (Haliaeetus leucocephalus) have been sighted in the area around St. Michaels.

Wetland Types

Approximately 90 acres of coastal salt wetlands are located in the immediate area of St. Michaels. This type of wetland is found along the landward side of salt marshes or bordering open water. The soil is always waterlogged during the growing season but its elevation is such that it is rarely covered by tidal waters. However, there may be a few inches of water over the soil at spring or high wind tides.

The wetland areas in St. Michaels are under private ownership and occur along Fairview Point, Spencer Creek, San Domingo Creek, and Long Haul Creek. Fishing and waterfowl hunting are permitted in most of these areas. The dominant vegetative species are Spartina alterniflora, S. patens, S. cynosuroides, Distichlis spicata, Scirpus americanus, Iva spp., Baccharis hamifolia, Potamogeton pectinatus, and Myrica cerifera.

TILGHMAN ISLAND, MARYLAND

Tilghman Island is located in Talbot County, Maryland, which is located in the central part of Maryland's Eastern Shore. The County lies on the west-central edge of the Delmarva Peninsula, a body of land which extends in a southerly direction between the Chesapeake Bay to the west and the Atlantic Ocean to the east. The County is comprised of 178,560 acres, or 279.4 square miles.

Talbot County is basically flat and low except for a few rolling areas in its northeast section. The County's most notable physical features are its proximity to the Chesapeake Bay and its extensive and irregular shoreline formed by numerous rivers,

creeks, and coves. Of the County's 608 mile perimeter, over 600 miles are waterfront which results in 99 percent of the county being surrounded by water.

Tilghman Island Harbor is located at Avalon, Tilghman Island, Maryland. Tilghman Island is about 3.5 miles long and 1 mile wide and is separated from the mainland of Talbot County by a waterway--Knapps Narrows. Tilghman Island Harbor empties into a small cove adjacent to Harris Creek on the eastern side of Tilghman Island and is approximately two miles above the confluence of Harris Creek and Choptank River. Tilghman Island, like all the island fragments along the Eastern Shore, is relatively flat. The island is a willowy place, well wooded and a sportsman's paradise. The impression often given when speaking of Tilghman Island is that of a pastoral scene - with its fleet of fishing craft reflecting a way of life dating back to a prior century.

Talbot County was first settled by the English in the 1630's and was constituted as a county in 1661. The County's three largest towns, Easton, St. Michaels, and Oxford developed on sites accessible to the water and became busy with port activity. Easton, because of its centralized location, became a hub of land transportation.

Since its earliest days, the County has relied heavily upon its natural resources. Products of the soil and waters have been the backbone of its economy. The original forests provided wood for shipbuilding, the newly cleared lands produced lucrative tobacco crops, and seafood harvesting became an important source of income. In the 19th Century, the County's agriculture shifted to the raising of vegetables. Mechanized farming methods replaced the earlier labor-intensive agriculture, and corn, soybeans, and poultry raising became the major source of farm income. The harvesting of seafood continued to provide a livelihood for many county residents, and has retained its importance to the present day, contributing most to the "character" of the county.

Talbot County has been traditionally one of the leading counties in the Maryland seafood industry in terms of pounds of landings and value of catch. Talbot County watermen have specialized mainly in shellfish, oysters, clams, and crabs. The seafood industry has been the livelihood of waterfront communities such as Tilghman and Avalon. The towns are inhabited by Chesapeake Bay watermen, individuals employed in seafood preparation and packing houses, or people in the supporting services.

EXISTING RECREATION RESOURCES

With its 600 miles of shoreline and many marsh and wooded areas, Talbot County has exceptional natural assets for recreational use. Water-oriented recreational activities have been especially popular for both county residents and persons from ouside the County. Several marinas and numerous private boat docks are present in the various rivers and creeks, and the presence of water constitutes a major visual element in the appearance of Tilghman Island and many other settlements in the western part of the County.

According to a 1976 Talbot County Recreation Sites Map the key areas for recreation in Tilghman Island are located at the Tilghman public school, Kronesburg Park and the public landings at Dogwood Harbor, Fairbanks, Bar Neck and Knapps Narrows.

FUTURE RECREATION CONSIDERATIONS

A comprehensive Outdoor Recreation and Open Space Plan has been prepared by the Maryland Department of State Planning. The Phase II publication of this plan enumerates a number of proposed recreation projects for Talbot County and the surrounding areas. One suggestion has been made: a limited recreation area for Tilghman Island. The plan recommends that the State and County participate in preserving the open character of the area through conservation zoning and acquiring development rights or easements at some locations.

Proposals were also made for a Love Point Recreation Area, located at Tilghman Point just north of Claiborne. The plan recommends that the State and County participate in acquiring land and developing it for boating, swimming, fishing, and limited picnicking. The proximity of this recreation area may provide recreational opportunities for the residents of Tilghman Island.

Three other areas for recreational use have also been identified for the Tilghman area. These are outlined in the 1979 Talbot County Annual Report on Parks and Recreation and are as follows:

(1) Tilghman has received from the Federal government some Coast Guard property for recreational use,

(2) The Talbot Softball League has volunteered to build a new field at the Tilghman Elementary School, and

(3) Kronesburg Park has been offered to the County as a new park.

ENVIRONMENTAL RESOURCES

Water Quality

Knapps Narrows and Harris Creek have been classified by the State of Maryland as Class II waters which are areas designated for shellfish harvesting. Information furnished by the Maryland Department of Health and Mental Hygiene, Environmental Health Administration and the Talbot County Environmental Health Division indicate that the waters within close proximity to the entirety of Tilghman Island are closed to shellfish harvest because of poor septic systems on the islands. Water samples taken at stations near the channel along Dogwood Harbor reveal instances where the coliform count exceeds Maryland standards. Some sampling data are shown in Table C-23.

TABLE C-23

BACTERIOLOGICAL WATER QUALITY DATA
FOR THE
KNAPPS NARROWS AREA

Date	Rain	Tide	18T Coliform	Fecal Coliform	33 Coliform	Fecal Coliform	34 Coliform	Fecal Coliform
5-20-75	Yes	Flow	150	93	--	--	--	--
6-23-75	No	Ebb	240	-3	1,100	-3	43	91
7-8-75	Yes	Ebb	210	-3	21	3.6	2,402	15
8-5-75	Yes	Flow	23	-3	3.6	-3	36	-3
9-20-75	Yes	Ebb	-	-	93	93	93	21
10-9-75	Yes	Ebb	-	-	15	-3	23	-3
11-4-75	No	Flow	460	240	23	23	460	23
3-1-76	No	Ebb	23	-3	460	43	36	-3
4-6-76	Yes	Ebb	93	-3	23	-3	43	-3
5-25-76	No	Slack	-	-	-	-	9.1	-3
6-1-76	Yes	Flow	43	-3	-3.6	-3	9.1	-3

SOURCE: Maryland Department of Health and Mental Hygiene.

Biota

Benthic Invertebrates

The waters around Tilghman Island provide habitat for numerous benthic invertebrates. While most benthic invertebrates do not possess any direct commercial value, they are very important to commercial and sport fishery resources by virtue of their role in the food web. A limited quantitative sampling of a shallow water area at Dogwood Harbor in October 1977 by the U.S. Fish and Wildlife Service revealed a diverse number of species of benthic invertebrates, many of which are utilized as food sources by finfish and waterfowl. The results of that sampling activity are shown in Table C-24.

Shellfish harvesting and related industries are the main employers in the Tilghman and Knapps Narrows areas. The open waters in the area are relatively shallow, usually less than 20 feet deep, and have a hard bottom. These conditions are especially favorable for oysters (Crassostrea virginica), soft clams (Mya arenaria), and blue crabs (Callinectes sapidus), which are the major commercial shellfish resources in the area.

Harris Creek and the Chesapeake Bay contain many natural oyster bars. Several of these bars were monitored by National Marine Fisheries Service (NMFS) biologists between 1963 and 1969 to determine annual oyster larval setting patterns. It was found that setting in this area began in middle to late June, consistently peaked the first week in July, and continued through August into September. Good spat retrieval occurred in Harris Creek, and it was characterized as an area of good recruitment.

TABLE C-24

QUALITATIVE SAMPLE OF BENTHIC INVERTEBRATES
AT DOGWOOD HARBOR
(October 1977)

Annelida
- Polychaeta
  - *Haploscoloplus fagilis*
  - *Heteromastus filiformis*
  - *Nereis succinea*

Arthropolda
- Crustacea
  - Decapoda
    - *Callinectes sapidus*...blue crab
    - *Palaemenetes pugio*...shrimp
  - Amphipoda
    - *Lepidacylus dytiscus*
    - *Leptocheirus plumulosus*
    - *Gammarus palustus*
    - *G. mucronatus*
    - *G. sp.*
  - Isapoda
    - *Cyathura polita*
    - *Edotea spi*
  - Cirripedia
    - *Balanus sp.*
  - *Limulus polyphemus*

Mollusca
- Bivalvia
  - *Mulinia lateralis*...little surf clam
  - *Macoma balthica*
  - *Macoma phonax*
  - *Mya arenaria*...soft clam

Chordata
- Tunicata
  - *Molgula manhattensis*...sea squirt

SOURCE: Sampling results provided by the U.S. Fish and Wildlife Service, October 1977.

Finfish

Finfish in the vicinity of Tilghman Island and Knapps Narrows include those species typical of the Chesapeake Bay at a salinity of 9-14 ppt. The more important commercial species include striped bass (Morone saxatilis), spot (Leiostomus xanthurus), weakfish (Cynoscion regalis), and white perch (Morone americana). Spawning grounds are not known to exist in this area; however, the lower Choptank River, to the east, serves as a nursery ground for many commercial species. Several other species found in this vicinity are listed in Table C-25.

Waterfowl

The Tilghman Island vicinity is an important concentration area for a great variety of waterfowl and supports the greatest local concentration of breeding black ducks (Anus rubripes) in the entire Upper Chesapeake region. Canada geese (Branta canadensis) and canvasback duck (Aythya valisineria) make up the largest percentage of the waterfowl population, followed by black ducks and American widgeons (Mareca americana). Great blue heron (Ardea herodias) and gulls (Larus spp.) are year-round residents in the Knapps Narrows environs, and whistling swans (Olor columbianus) are present nearly year-round.

Rare and Endangered Species

The Delmarva fox squirrel, the bald eagle, and the red cockaded woodpecker are the only endangered species which are likely to inhabit the county. None of these endangered species are known to inhabit the immediate area around Tilghman Island.

Wetland Types

The most significant areas of wildlife habitat in the County are in wetland areas on and adjacent to the shoreline. These shallow areas of the rivers and bays serve as spawning grounds for many species of fish and invertebrates while providing nourishment for young animal forms and protecting them from predators and rough water. The marsh areas generate organic nutrients which constitute vital links in the food chain of the Bay.

Talbot County, with its numerous coves and inlets, has about 8,600 acres of wetland. Tilghman Island Harbor was part of a wetland prior to its being dredged and bulkheaded in 1971. Both the Tilghman and Knapps Narrows areas have marshes in close proximity.

In 1968, the State of Maryland inventoried then existing wetland communities of five acres or greater throughout the State. This information was published in 1973. The wetlands numbered 52 and 53 are adjacent to the Knapps Narrows channel and disposal sites. Wetland number 57 is adjacent to Tilghman Island Harbor.

Aerial photographs taken in March 1977, and a site visit made in April 1979, have verified the continued existence of wetland 52 and most of wetland 53. The portion of wetland 53 closest to Knapps Narrows channel and the portion near Route 33 has been converted into a housing and commercial development. The remainder of the marsh still exists and is viable. The State of Maryland considers these wetlands to be moderately to highly vulnerable to change. The principal vegetative species in these wetlands include

TABLE C-25

ORGANISMS COLLECTED DURING THE TRED AVON RIVER SURVEY (April 1975 to 1979)

Species Collected in Spawning Condition

1.	Atlantic silversides	*Menidia menidia*
2.	Common killifish	*Fundulus heteroclitus*
3.	Striped killifish	*F. majalis*
4.	Freshwater killifish	*F. diaphanus*
5.	Sheepshead minnow	*Cyprinodon variegatus*
6.	White perch	*Morone americana*
7.	Grass shrimp	*Palaeomonetes pugio*
8.	Horseshoe crab	*Limulus polyphemus*

Species Collected in Juvenile Stages

1.	Atlantic silversides	*M. menidia*
2.	Killifish	*Fundulus sp.*
3.	Sheepshead minnow	*C. variegatus*
4.	White perch	*M. americana*
5.	Striped bass	*M. saxatilis*
6.	Bluefish	*Pomatomus saltatrix*
7.	Winter flounder	*Pseudopleuronectes americanus*
8.	Atlantic croaker	*Micropogon undulatus*
9.	Atlantic needlefish	*Strongylura marina*
10.	Green goby	*Microgobius thalassinus*
11.	Menhaden	*Brevoortia tyrannus*
12.	Blue crab	*Callinectes sapidus*
13.	Blueback herring	*Alosa aestivalis*
14.	Spot	*Leiostomus xanthurus*

Other Species

1.	Northern pipefish	*Syngnathus fuscus*
2.	Clingfish	*Gobiesox strumosus*
3.	Bay anchovy	*Anchoa mitchilli*
4.	Toadfish	*Opsanus tau*
5.	Hogchoker	*Trinectes maculatus*
6.	American eel	*Anguilla rostrata*
7.	Striped mullet	*Mugil cephalus*
8.	Red-eared sunfish	*Lepomis microlophus*
9.	Carp	*Cyprinus carpio*

SOURCE: U.S. National Marine Fisheries Service.

saltmarsh cordgrass (Spartina alterniflora), saltmeadow cordgrass (Spartina patens), needlerush (Juncus roemerianus), saltgrass (Distichlis spicata), and marsh elder (Iva frutescens).

Wetland number 57 has been nearly eliminated. Dredging and bulkheading for Tilghman Island Harbor destroyed most of this marsh. Aerial photography from March 1977, and a field visit in November 1978, confirmed that only a thin strip of marsh along the shoreline south of the harbor and a small portion north of the harbor still exist. Both of these areas are adjacent to housing developments and are considered highly stressed and likely to disappear. These three major wetlands are described in Table C-26.

CAPE CHARLES, VIRGINIA

Cape Charles is located on the eastern shore of the Delmarva Peninsula approximately 11 miles from the entrance of the Chesapeake Bay. It is in Northampton County, Virginia, which was one of the first eight Virginia Shires established in 1634. The city was incorporated in 1886 when it represented the terminal point for the Pennsylvania Railroad. It was here that railroad and passenger cars were loaded on a ferry and transported out of the area. The ferry was discontinued in 1951 and, since that time, the population of Cape Charles has decreased to its present size of approximately 2,000. (Results of the latest decennial census indicate that Cape Charles had a 1980 population of 1,512 residents.) Today there is little industry in the city, with much of the employment associated with water-related activities.

RECREATION RESOURCES

The City of Cape Charles is one of the major sport fishing centers on the Eastern Shore. Seasonally, the bluefish are common in April and early May with large catches of black drum concentrated in May. Gray trout season follows, with flounder caught in significant numbers during late spring and early summer. Croakers are abundant from June through August, with spot coming in July and August. The fall catches include spot, bluefish, and flounder. In addition to good fishing potential in near and offshore waters, Cape Charles provides attractive harbor facilities, an abundant supply of charter boats, and a seasonal variety of fish. The commercial finfishery is mainly derived from pound nets. However, these nets are more common south of Elliotts Creek, rather than in the close vicinity of Cape Charles Harbor.

In addition to sport fishing, recreational resources available in Cape Charles include other saltwater-related activities. These include swimming, sailing, sun bathing, and other water sports. There are numerous summer cottages used by summer residents or tourists with a golf course located just south of Kings Creek. Waterfowl hunting is also popular as numerous duck hunters come to the area every fall.

TABLE C-26

WETLAND AREAS AND PRINCIPAL BIOTA IN THE
GENERAL VICINITY OF TILGHMAN ISLAND

County Wetland Unit Number: Talbot #52
Wetland Name: Front Creek
Wetland Type: 18
Total Acres: 52
Dominant Vegetation:
- Saltmarsh cordgrass, *Spartina alterniflora*
- Needlerush, *Juncus roemerianus*
- Hightide bush, *Baccharis halimifolia*
- Salt grass, *Distichlis spicata*
  - *Spartina patens*
  - *Iva*

County Wetland Unit Number: Talbot #53
Wetland Name: Back Creek
Wetland Type: 18
Total Acres: 122
Dominant Vegetation:
- Myrtle
- Saltmarsh cordgrass, *Spartina alterniflora*
  - *Spartina patens*
- Wigeongrass,
- Hightide bush, *Baccharis halimifolia*
  - *Iva*

County Wetland Unit Number: Talbot #57
Wetland Name: Avalon
Wetland Type: 17
Total Acres: 29
Dominant Vegetation:
- Myrtle
- Saltmarsh cordgrass, *Spartina alterniflora*
  - *Spartina patens*
  - *Iva*
- Pine
- Hightide bush
- Wigeongrass

Wildlife Common to Wetland Areas Above (52, 53, 57).

Principal Finfish: Spot, Striped Bass, White Perch
Principal Shellfish: Crab, Oysters, Soft-shelled clams
Principal Waterfowl: Puddle ducks, Whistling swan, Wigeon, Canada Goose
Upland and Shoreline Bird Use: Gulls, Sandpiper, Great Blue Heron, Osprey, Bobwhite Quail
Principal Mammals: Opossum, Skunk, Raccoon, Fox, Whitetail Deer, Rabbit, Squirrel
Use: Fishing
Assessment of Wetland Use: Osprey Nesting

SOURCE: Maryland Department of Natural Resources, County Wetland Inventory.

ENVIRONMENTAL RESOURCES

Biota

The blue crab fishing is a major activity in this region and it represents utilization of a major resource in Cape Charles. Birdsong (1979) estimated that over 1,000 crab pots were being used in the lower half of Cherrystone Inlet during the summer of 1978. Other nearby crabbing sites include Kings Creek and Old Plantation Creek. From May through October, a modest soft and peeler crab fishery is also active. Shellfish are also abundant in these waters, with numerous oyster bed leases in Cherrystone Inlet, Kings Creek, and Old Plantation Creek. However, there are no commercial oyster grounds in the offshore area (Dauer, 1979). The six major species of fish in the area are bluefish, black drum, gray trout, summer flounder, croaker, and spot. Birdsong (1979) indicates that these six species represent over 95 percent of the total sport catch in this local area. Several varieties of duck and geese are common. Along with other shore and marsh birds, they make up the migratory and resident bird populations.

Rare and Endangered Species

Within the Cape Charles area, there are no known rare or endangered species found in the local ecosystem.

Wetland Types

There is a wealth of natural resources in the Cape Charles area. These include an extensive saltmarsh acreage within nearby Kings Creek, Cherrystone Inlet, and Old Plantation Creek. The primary component of this wetlands habitat is the saltmarsh cordgrass community. In an evaluation of wetlands communities, Moore (1977) placed saltmarsh cordgrass into the Group I category which represents marshes of highest value in productivity and utilization by waterfowl and other wildlife. These marshes also play an important role as erosion inhibitors and stabilizers of the natural shoreline.

The average production from such a marsh is given as four tons per acre per year, with an optimum value up to ten tons per acre (Moore, 1977). Since much of the surrounding terrestrial land is undeveloped, there exists an extensive woodland acreage in the vicinity of Cape Charles. Additional land is in agricultural use or represents land formerly under cultivation. A variety of woodland fauna enriches these areas, including deer, numerous small mammals, and bird populations. In the offshore waters near Cape Charles are significant sea grass beds. These grasses are common to shallow bays and are ecologically important as a food source or haven to a variety of local fauna. These grasses also make a major contribution to the local setting by aiding in the stabilization of the offshore benthic region and by providing some deterrent to coastal erosion patterns.

HAMPTON ROADS, VIRGINIA

Hampton Roads, Virginia, is a natural harbor complex in southeastern Virginia where the James, Elizabeth, and Nansemond Rivers meet before entering the lower Chesapeake Bay. It is bordered to the north by the City of Hampton and a portion of the City of

Newport News. To the south are the Cities of Norfolk and Portsmouth, with Suffolk to the west and Virginia Beach and the Chesapeake Bay to the east. The City of Chesapeake borders portions of the Elizabeth River which enters Hampton Roads.

Historically this is one of the most significant areas of colonial America. Hampton Roads was navigated by Captain John Smith in 1607 and became the waterway leading to the settlements at Jamestown, and other sites in what is now southeastern Virginia. Hampton was named for the Earl of Southampton and was built by the English in 1610 on the site of the former Indian Village of Kecoughtan (Division of State Planning and Community Affairs, 1973, now the Department of Intergovernmental Affairs). It became a town about 1691, was incorporated in 1887, and became a city in 1908. Located at the entrance of strategic Hampton Roads Harbor, the City has experienced military actions in the Revolutionary War, the War of 1812, and the Civil War. Off its shore, within Hampton Roads, the epic Civil War encounter occurred between the two ironclad vessels - the Merrimack and the Monitor.

Norfolk also has a long and colorful history that dates back to the early 1600's when colonists began to settle on its shores. Land was purchased for a settlement in 1680. Norfolk became a town in 1705 and a city in 1845. The city has a land area of 50 square miles and is situated on low land practically surrounded by water and has an average elevation of 13 feet. Norfolk is a leading retail trade center and port city with extensive highway, rail, and air transportation facilities. The Norfolk-Portsmouth area is the center of the world's largest naval concentration with various associated installations. This city complex is a center for trade, transportation, and military activity.

Portsmouth and Norfolk share a similar history of early colonization and port-related development. Captain John Smith first sailed up the Elizabeth River in 1608, with colonists soon after settling along both sides of this waterway. One section, owned by William Crawford, was subdivided into 1/2 acre lots to establish the town of Portsmouth in 1752. In 1858, it became a city. During this early period, Portsmouth established itself as a naval base, trading, and shipbuilding center. Due to its strategic role and location, the city was also exposed to the armed conflict, occupation, and calamities associated with the Revolutionary War and the Civil War. In modern times Portsmouth is a major port within Hampton Roads with extensive shipyards, naval installations, and harbor-related activities.

In contrast to the other cities in the Hampton Roads complex, Chesapeake has a recent origin. The City was formed in 1963 from a consolidation of the City of South Norfolk and Norfolk County. However, the area itself has a long history going back to when Norfolk County was established in 1636. Chesapeake is the Commonwealth's largest city having a total area of 350 square miles. Its lands are predominantly wooded or in agricultural usage. It has contact with the Hampton Roads area via the southern and eastern branch of the Elizabeth River.

RECREATION RESOURCES

The Hampton Roads regional recreational status was appraised in the Virginia Outdoors Plan 1979 by the Commission of Outdoor Recreation. Recreational facilities in this area are extensive and include parks and recreational areas, natural forests, wildlife management areas, natural areas, public fishing lakes, public boat landing sites, historic

preserves, scenic highways, a scenic river, and various trails. In addition, there are bathing beaches, numerous marinas, many picnic sites, bike trails, inland hunting and marine recreational fishing areas. Hampton's Recreation Department has a year round program that includes games, sports, music, arts and crafts. Various cultural and sports programs, among other activities, are provided at the Hampton Roads Coliseum which seats over 11,000. A major tourist attraction is the Mariners Museum and the Hampton Tour program. Other recreational activities include concerts, dinner theaters, and seashore activities to include swimming, boating, sailing and waterskiing.

Norfolk also has an extensive program sponsored by its Department of Parks and Recreation. The city has a zoo, swimming pools, athletic fields, tennis courts, picnic areas, and a tour program. A multi-purpose facility called SCOPE is located in the center of Norfolk and is used for athletic events, conventions, and various entertainment activities. In addition, there is the Chrysler Theater, the Chrysler Museum, the MacArthur Memorial and numerous houses and sites of historical significance.

Portsmouth, Chesapeake, Virginia Beach, and Newport News also offer a variety of recreational facilities for both residents and tourists similar to those provided in Norfolk and Hampton. In addition to park and picnic facilities, there are numerous community centers, playground areas, athletic playing fields, and a variety of cultural activities that provide multiple alternatives for recreation. As in Norfolk and Hampton, water-related activities are very popular. Marinas are common, with numerous commercial docks and private piers found along the waterways. Swimming, boating, sailing, shellfishing, and finfishing are common throughout the area. A unique recreational resource in Chesapeake is the Great Dismal Swamp which is a National Wildlife Refuge that has programs and facilities available to the public. With its excellent beaches, Virginia Beach attracts thousands of tourists and vacationers from as far away as Canada. Seashore State Park, a 2,780-acre natural area with camping and cabin facilities is also located here.

The Hampton Roads complex has more than 22 percent of the state's population and has developed an extensive array of recreational outlets for its residents. However, with reference to park and recreational acreage measured by suggested planning standards, the region is indicated by the Virginia Outdoors Plan 1979 to be only 63 percent adequate in local and regional parks. The Plan also indicates that many of the State and Federal properties have adequate acreage but have limited access and usage for the local population. Specific deficiencies have been identified in the State Plan, with recommendations directed to local, State, and Federal concerns to overcome these deficiencies.

ENVIRONMENTAL RESOURCES

Biota

Natural resources in the Hampton Roads area include the seafood harvest that comes from the local waters. Extensive shellfishing and finfishing activities are concentrated within the Hampton Roads region and include both commercial and recreational interests. Of major importance are the fisheries for oysters, clams, blue crabs, and a variety of finfish. Within the marshes dwell a variety of small mammals, resident and migrant birds, and invertebrates, among others.

Rare and Endangered Species

Within the Hampton Roads regional complex, there are no known rare or endangered species.

Wetland Types

Important natural resources in the Hampton Roads area would include the deep water harbor, the waterways provided by the various rivers, the Chesapeake Bay, and the estuarine ecosystem formed within this complex. An important ecological component of the estuary is the wetlands. From Wetlands Guidelines 1974, 12 types of wetlands were identified and classified according to their ecological value. The wetlands common to the Hampton Roads complex are composed mainly of saltmarsh cordgrass which is listed in Group I in the above mentioned Guidelines, and is considered to have the highest productivity value and utility by wildlife and waterfowl. Detrital products from these marshes are important components of the local ecosystem, with the marshes closely associated to fish spawning and nursery areas. In addition they act as natural stabilizers to the local shoreline, reducing erosion. The average annual yield from these marshes is four tons per acre, with optimal growth up to ten tons. The major component of this community is the saltmarsh cordgrass (*Spartina alterniflora*). Also associated with this species on slightly higher elevations is salt meadow hay (*Spartina patens*) and saltgrass (*Distichlis spicata*). Frequently found on small hummocks within the marsh will be the saltbushes, the marsh elder (*Iva frutescens*), and the groundsel tree (*Baccharis hamilifolia*).

Tidal cycles provide the transport mechanism for many of the marsh products (e.g. detritus) to enter the local waters. Fringe marshes are common to the area and are found along some of the older bulkheaded sections and locations between these areas. Within the creeks and rivers, embayed and cove marshes are common, with some extensive marsh sections present. A limited amount of marsh is found along the southern extent of Hampton and in Hampton River. The most developed marsh area in Hampton is in the Mill Creek section, in the salt ponds, in the Long Creek area, and within the tributaries of the Back River and along the Back River. The Elizabeth River complex contains a highly developed port facility where the lower segments of each branch possess mostly artificially stabilized and bulkheaded shorelines. Creeks entering these sections, plus the headwater creeks and upper reaches of the three branches of the Elizabeth River, contain extensive embayed marshes and fringe marsh areas. Many of these marshes are bordered by natural woodland.

POQUOSON, VIRGINIA

Poquoson is located in the southeast corner of York County, Virginia. It is on what is commonly called the Peninsula, which lies between the James River and the lower Chesapeake Bay. The history of Poquoson goes back to the early colonial times in Virginia. The name was derived from an Indian word meaning low land or great marsh. First mention of the town dates back to 1631 when Captain Christopher Calthorpe recorded the town in an English land patent. In the early years, it was a small community with an agricultural and seafood orientation. Even today the seafood industry is the major economic activity of the City. In the late 1800's what is now Poquoson was actually three separate communities (Poquoson, Odd, and Messick) that became incor-

porated as a town in 1952 with a population of about 2,700. In 1975, Poquoson was chartered as a city, and presently consists of approximately 15.6 square miles with about 60 miles of shoreline. The developed land use is mainly residential and consists of predominantly single family dwellings. However, approximately 65 to 70 percent of the city land area is undeveloped, with a large portion of this being wetlands (Forrest, 1979).

RECREATION RESOURCES

A variety of recreational facilities are available in Poquoson. Of major interest are those related to water activities. These include fishing, swimming, crabbing, water skiing, and general pleasure boat usage. Several public boat ramps are available at scattered sites throughout the city. Several baseball fields and playgrounds are also located near schools. In addition, there are outdoor tennis and basketball courts and picnic areas. A Federally funded park system is being constructed. Five of the six parks planned have been completed and the sixth is under construction. The parks provide a variety of recreational facilities to meet the needs of the City's increasing population.

ENVIRONMENTAL RESOURCES

Water Quality

The Virginia Water Quality Inventory (305b Report, 1982) states the northwest branch of the Back River "does not meet applicable water quality standards nor 305(b)(1)(B) criteria." These criteria are defined as "the extent to which all navigable waters provide for the protection and propagation of a balanced population of shellfish, fish, and wildlife, and allow recreational activities in and on the water." The report cites specifically (low) dissolved oxygen levels and fecal coliform problems attributed to waters from Brick Kiln Creek. The Northwest Branch of Back River has a "Water Quality Limiting" classification. The report does not provide any information for Bennett Creek. The report also states that the Poquoson River does not meet 305(b)(1)(B) criteria. The Poquoson River has an "Effluent Limiting" classification.

Biota

A major part of the local economy is derived from water-based activities, mainly harvesting shellfish and finfish. The most abundant landings in Poquoson are oysters, blue crabs, and hard clams. There are also numerous pound nets in the area. Major fish brought in from pound nets and haul seines include blue fish, croaker, and spot. The nearby waters also contain considerable acreage leased for shellfish growth and harvest. There are 548 acres leased in the Poquoson River and 197 acres leased in Bennett Creek, with additional holdings in the tributaries to Bennett Creek. Some of the Bennett Creek acreage is used for the depositing of hard clams taken from the James River for cleansing purposes. The marshes also contain a variety of resident and migratory birds, small mammals, and a variety of other animals.

Rare and Endangered Species

The Poquoson area contains no known rare or endangered species.

Wetland Types

The natural resources of Poquoson include its natural woodlands, coastal wetlands, local wildlife and its harvest from nearby waters. Possessing basically a rural setting, the local biota consists of a variety of terrestrial forms associated with woodlands, marsh, and sparsely inhabited agricultural lands. The local wetlands and extensive marsh habitat of the Plum Tree Island Refuge are highly productive lands, providing both food and haven to a large assemblage of animals. The marshes also play an important role as a sediment trap and in reducing the impact of flooding. This type of marsh stability also reduces shoreline erosion and aids in stabilization of the shore around Poquoson. The marshes represent an essential component of the local ecosystem and merit preservation.

TANGIER ISLAND, VIRGINIA

RECREATION RESOURCES

There are limited recreational facilities associated with Tangier Island. A recreational center building and the playground area of the island school represent designated sites for recreational activities. Children are frequently seen playing in yards and on the narrow streets. Bicycles and motorcycles are very common but appear to be used mainly for transportation. Very few automobiles are on the island. Seasonally, hunting serves as both a recreational and food-providing function. The typical waterborne activities associated with finfish and shellfish activities are conducted mainly as a means of livelihood rather than for sport. Swimming also appears to be limited as good swimming beaches are not easily accessible. Walking and bicycling are probably the most common physical activities on the island. Much of the community life is also centered in the churches, so a definite amount of church-related activity is common throughout the year. However, there are numerous recreational services the islanders provide to visitors. These include transportation services for waterfowl hunters and game fishermen. Other tourists arrive aboard daily tour ships to the island or by airplane. These visitors come mainly during the summer months from Reedville, Virginia, and Crisfield, Maryland. These tourists engage in sightseeing activities as they walk on the island.

ENVIRONMENTAL RESOURCES

Water Quality

The water quality in the surrounding waters and the Tangier Island Harbor area is subject to point source loadings due to malfunctioning septic tanks. This results in poor water quality caused by lowered dissolved oxygen values as well as a health hazard due to increased coliform bacterial levels. This situation is furthered by the high water table that aids in the movement of septic tank leachate in ground water or surface water as a primary pollution source. The Virginia Water Quality Inventory (305b report, 1982) also mentions that local waters are contaminated by general surface runoff due to the island's large domestic animal population, the use of surface privies, and the general pattern of solid waste disposal. A new wastewater treatment plant was scheduled to become operational in late 1983. This should help to ease the problem caused by the inadequate

pattern of water disposal now in use. The plant will discharge its effluent into the Chesapeake Bay. This will allow considerable dilution of nutrient loads and reduce the effects of the biochemical oxygen demand and bacterial levels.

Biota

The local biota include the characteristic species important to regional wetland habitats and the commercially significant finfish and shellfish of the Chesapeake Bay. The major fishing resource of the island centers on the blue crab (Callinectes sapidus). Emphasis is placed on both the hard crab fishing and soft crab fishing (Burrell, et al., 1972). The hard crabs are harvested in crab pots generally between April and November. From December to March the local watermen may tong oysters in the Potomac River or go to the lower Chesapeake Bay for the dredge crab fishing. The soft crab fishing centers on peeler crabs that are caught and held in wooden floats until they shed their outer skeleton and are sold as soft crabs. Nearby oyster bars are not commercially productive. The finfishing centers on gill net catches of bluefish (Pomatomus saltatrix), grey trout (Cynoscion regalis), and striped bass (Morone saxatilis).

Rare and Endangered Species

At present, there are no known rare or endangered species associated with the ecosystem on Tangier Island.

Wetland Types

The Tangier Island complex itself represents a natural resource of a saltmarsh community, rich in wildlife and flora, that contributes to the general productivity of the region. Approximately 750 of the 970 acres, or 77 percent, of the island are composed of saltmarshes (Silberhorn, et al., 1977). These marshes are dominated by communities of saltmarsh cordgrass, saltmeadow hay, and black needlerush, which are all major contributors to the maintenance and support of the local ecosystem. They represent major producers of organic matter, provide a suitable habitat for various wildlife (including waterfowl and small mammals), assist in reducing erosion effects, and aid in water quality control. The waters surrounding the island and within its harbor contain a variety of shellfish and finfish resources that are the center of the islanders commercial and harvest activities. To a lesser extent, hunting of various waterfowl also takes place.

WEST POINT, VIRGINIA

West Point has a long and interesting history that centers on two of its most valuable natural resources. These are its forests and the adjacent rivers that provide excellent water routes for transportation and commerce. The Indian village, Cinquotek, was located here when the area was visited in 1608 by Captain John Smith. The section was included in the Charles River Shire formed in 1634 in colonial Virginia and became part of former Governor John West's 3,000-acre plantation in 1653. By 1701, a small town called Delaware was located on the neck, or point, of land that extended into the river complex, which was also called West Point. However, the town eventually became

absorbed into another plantation in 1839, and it wasn't until over 20 years later that new growth occurred. Due to the deep channels coming into West Point from the York River, the site became important as a possible deep water terminal. In 1861 this became evident when the railroad from Richmond extended its eastern terminus to West Point.

The Civil War brought both confederate and Federal troops to West Point, as well as gunboats up the York River. After the war, city growth and rapid development continued until 1895, when the railroad terminus was moved farther eastward to Portsmouth, Virginia. The population and economic development declined rapidly after that. In recent times, the Town of West Point has become an industrial center with a population of approximately 2,700 with activities centering around lumbering, paper mill operation, and associated transportation needs. The Norfolk Southern Railroad system now services West Point with its chief client being The Chesapeake Corporation of Virginia, whose main products are pulp and paper. The pulpwood is brought into town by rail, trucks, and barges to the mill. Truck, rail, and water routes are also used to transport the pulp and paper products.

RECREATION RESOURCES

In the vicinity of West Point, a variety of indoor and outdoor recreational activities are available. There is a downtown Community House and a Recreation Center with a basketball court, skating rink, a stage, 1,500 seat auditorium, dining room, indoor rifle range, and outdoor playground. There is also a community athletic field where recreational league baseball and high school athletics are played. The West Point Country Club has a nine-hole golf course, two swimming pools, picnic area, tennis courts, and a 10-acre lake. Seasonally, outdoor recreation includes hunting, fishing, and a variety of other water sports. The local rivers offer fishing with bass, pike, bream, rock fish, and shad during the spring runs. Common game include deer and quail. Pleasure boat usage is another activity, with several public boat ramps available. It is anticipated that these recreational resources will continue into the future and meet the future demand.

ENVIRONMENTAL RESOURCES

Water Quality

The Virginia Water Quality Inventory (305b Report, 1976) identifies the lower Pamunkey and Mattaponi Rivers and the upper York River as not meeting the 305b criteria; however, the water quality of the York River is considered good by Heyer (1977). The 305b criteria are defined as "the extent to which all navigable waters provide for the protection and propagation of a balanced population of shellfish, fish, and wildlife, and allow recreational activities in and on the water." The report identifies several industrial and municipal dischargers into the river system. These include the Chesapeake Corporation at West Point and the West Point Sewage Treatment Plant. The Pamunkey River has also become degraded due to natural wetlands and agricultural runoff patterns upstream. In its lower segment, the water quality of the stream is influenced by discharges from the Chesapeake Corporation pulp and paper mill. It is suspected that runoff from wood chip piles causes false fecal coliform counts due to the Klebsiella organism found in wood fibers. This point deserves more study to more fully evaluate the bacterial composition in the local waters. The company's sewage treatment plant is in

compliance with the National Pollutant Discharge Elimination System regulations. The Water Quality Inventory Report (305(b), 1982) has classified this segment of the Pamunkey River as "Water Quality Limiting."

The lower Mattaponi River also has runoff from the wetlands and agricultural lands with accompanying values in dissolved oxygen levels and pH that do not meet 305b criteria. The portion of the river that is adjacent to West Point also receives outflow from West Point Creek. This is the receiving stream for the West Point Sewage Treatment Plant. Urban runoff, landfill runoff, and organic drainage from the wetlands enter this creek. The Virginia Water Quality Inventory Report (1982) classifies this portion of the Mattaponi River as "Effluent Limiting." The upper York River, which receives the Pamunkey and Mattaponi Rivers, contains fecal coliform bacteria and coloration that prevent it from meeting 305b criteria. The Water Quality Inventory 305(b) Report states that "In the past high fecal coliform levels from undetermined sources have kept portions of this segment from meeting Water Quality Standards and 305(b)(1)(B) criteria. These sources are possibly individual dwellings with inadequate or non-existent sanitary facilities, overflows and/or bypasses of sanitary sewers during heavy rainfall, animal waste runoff and upstream runoff from Chesapeake Corporation." This segment of the York River is classified as "Water Quality Limiting."

Biota

In the local waters, a variety of game fish are available to local sports fishermen as a recreational resource; however, there does not appear to be significant commercial fishery effort in West Point.

Rare and Endangered Species

With regard to the West Point community and its environs, there are no known rare or endangered species associated with the local ecosystem.

Wetland Types

Scattered along the eastern and western shoreline of West Point are fringe marshes and several sections of marsh development. Along the eastern margin of the town, West Point Creek enters the Mattaponi River. Extensive areas of saltmarsh stands are common along both shorelines of the Pamunkey and Mattaponi Rivers. Similar development is common along the York River. These are basically saltmarsh cordgrass communities which are highly productive and play a significant role in the local ecology. They act as erosion inhibitors and stabilizers to the natural shoreline, function as a sediment trap, and assimilate floodwaters. The saltmarsh cordgrass community is considered by Moore (1977) as one of the most productive types of wetland habitats that has an average production value of four tons per acre per year, with an optimum value up to ten tons per acre per year (Wetlands Guidelines, 1974). These marshes also serve as an important resource utilized by resident birds and mammals and migratory waterfowl. Much of the woodland areas bordering these marshes is also rich in local fauna and is relatively undisturbed.

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